JANUARY 1955

Power Engineering

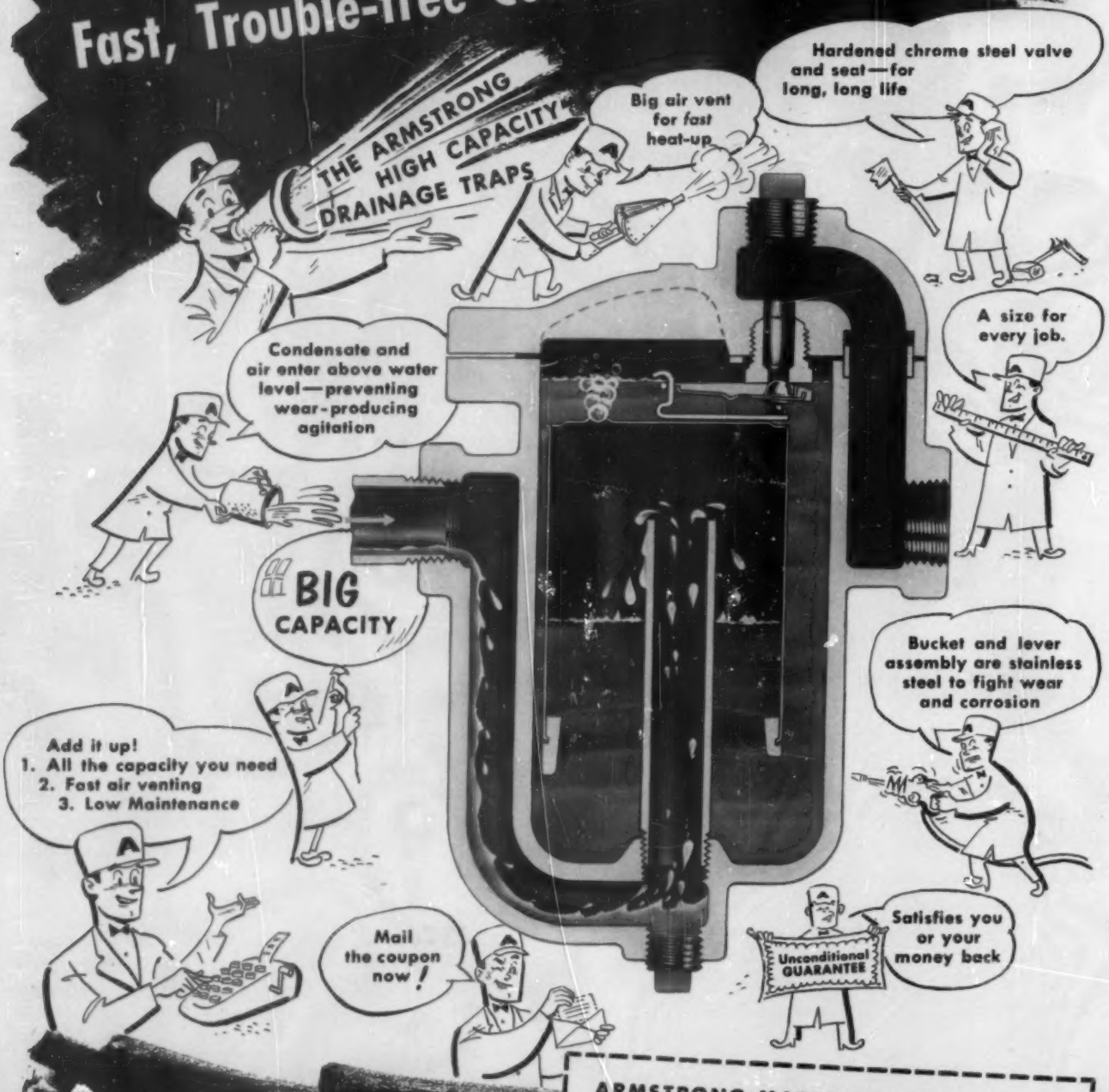
ANNUAL REVIEW OF 1954 Power Field Developments 55
In the Power Field . . . . All Trends Continue Upwards 55
Our Fuel Reserves Won't Last Forever 56
Highlights of Atomic Power Developments 58
Progress in Power Plant Details Paces Upward Trends 62
Hydro, Diesels, Gas Turbines Share in the Gains 66
Electric Circuits – Old and New 68
Two-Stroke Gas Engine Gets Second Wind 71
Electric Heat for CO_2 in Hydrogen Purging 72
Choose Motor Enclosures to Fit the Weather 74
Turbine Supervisory Instruments Give Vital Operating Data 76
Commonwealth's Ridgeland Unit No. 4 Explodes 78
Why the Air-Conditioning Cost Too Much 80
H-T Water Heats Limestone Base 82
This New Rapper Improves Electrostatic Precipitators 84
Make Sure Your Underground Metal Coatings Do Their Job 86

REGULAR DEPARTMENTS

Engineers' Preview 3
Here's What They Tell Us 6
Helpful Bulletins 25
Equipment News 44
Construction News 52
Power Engineering Handbook 88
Catalog Library 103
Readers' Service Post Cards 103
Advertisers' Index 110
Circulation of this Issue 36,130

here is the means for

Fast, Trouble-free Condensate Drainage


THE ARMSTRONG HIGH CAPACITY DRAINAGE TRAPS
Big air vent for fast heat-up
Hardened chrome steel valve and seat—for long, long life
A size for every job.
Condensate and air enter above water level—preventing wear-producing agitation
BIG CAPACITY
Bucket and lever assembly are stainless steel to fight wear and corrosion
Add it up!
1. All the capacity you need
2. Fast air venting
3. Low Maintenance
Mail the coupon now!
Unconditional GUARANTEE
Satisfies you or your money back

ARMSTRONG

INVERTED BUCKET STEAM TRAPS

ARMSTRONG MACHINE WORKS
810 Maple Street, Three Rivers, Michigan

☐ Send 44-page Steam Trap Book.

Name_____

Company_____

Street Address_____

City_____ State_____

For more data circle 502 on Post Card

ENGINEERS' PREVIEW

WHEN YOU SEE REPORTS from Stockholm, Sweden, about development of a power gas-driven locomotive, don't let that throw you. It's merely our old friend, the free piston machine exhausting to a gas turbine installed in a locomotive. The Swedes claim this will be the first one in the world to be so driven. Incidentally, the power from the gas turbine will be transmitted by way of a reduction gear and hydraulically-operated friction clutches to three driving shafts.

• • •

HIGH-VOLTAGE SWITCH was closed November 11 to link the electric transmission systems of Central Hudson Gas & Electric Corp. and Rockland Light & Power Co. The new connection, providing for an interchange of up to 50,000 kw on an economy or emergency basis, brings the Rockland company into an existing network linking Central Hudson, Niagara Mohawk Power Corp. and Consolidated Edison Co. of New York.

• • •

LARGEST steam-turbine generator in the world has been ordered for the River Rouge plant of The Detroit Edison Co., according to Edison's President Walker L. Cisler.

This new unit, designed to be one of the most economical ever built, is expected to produce a kilowatt-hour of electricity for less than ¾ lb of coal, approximately 30 per cent less than the national average.

The new unit — No. 3 at that plant — will have a capacity of 300,000 kw. A new boiler has also been ordered to supply steam to the turbine. This boiler will supply 2,000,000 lb of steam per hour at 2450-psi pressure and at 1050 F.

The turbine generator has been ordered from the Allis Chalmers Manufacturing Co., and the boiler from the Foster Wheeler Corp.; coal pulverizing equipment will be supplied by the Riley Stoker Corp.

• • •

ARCHITECTURAL and engineering plans are nearing completion for the new headquarters building in Washington, D. C., of the National Society of Professional Engineers. Located in the Northwest section of the Capital, the four-story, granite frame building will house the executive and administrative offices of the 33,000 member Society. Financing of the new headquarters will be handled through the sale of building fund participation certificates to the membership.

• • •

SIXTH ANNUAL Southeastern Instrumentation Symposium will be held on the campus of the University of Florida on January 31–February 2, 1955. Leading instrument manufacturers are participating in the instrument Show, and expert instrument men will be available for consultation.

For further information write to: W. C. Hackler Engineering and Industrial Experiment Station University of Florida, Gainesville, Florida.

• • •

D. & C. and WILLIAM PRESS, LTD., Civil, Mechanical and Chemical Contracting Engineers and Consultants of London, England, have been engaged by the Ministry of Fuel and Power and the Gas Council to appraise and report to the North Thames Gas Board, London, regarding liquefied natural gas and its particular application to Great Britain. (See POWER ENGINEERING, June 1954.)

Andrew Morrison, member of the Institute of Mechanical Engi-

EDITORIAL AND BUSINESS STAFF

POWER ENGINEERING IS PUBLISHED MONTHLY • 110 S. DEARBORN ST., CHICAGO 3, ILL. DEARBORN 2-5446

EDITORIAL AND ART STAFF

Editorial Director — Richard H. Morris
Editor — Andrew W. Kramer
Executive Editor — Chester R. Earle
Associate Editor — Norman S. Jones
Associate Editor — Robert J. Mitchell
Associate Editor — R. C. Hagenmiller
Equipment Editor — Marian E. Heniken
Assistant Editor — Irene M. Glen
Staff Artist — James E. Wilcox
Chief Draftsman — Robert W. Koster

OFFICERS AND BUSINESS STAFF

President — Kingsley L. Rice
Executive Vice President — Edwin C. Prouty
Vice President — Walter Painter
Vice President in Charge of Sales — Richard M. Ward
Treasurer — Arthur L. Rice, Jr.
Assistant Treasurer — Thomas Walsh
Secretary — Edwin C. Prouty, Jr.
Production Director — John O. Aarvold
Production Manager — Earl R. Noren

Technical Publishing Company is incorporated under the laws of the State of Illinois. Board of Directors: Kingsley L. Rice; Arthur L. Rice, Jr.; Andrew W. Kramer; Edwin C. Prouty; Richard H. Morris.

ADVERTISING SALES STAFF

Vice President in Charge of Sales — Richard M. Ward

DISTRICT MANAGERS

New England — Charles R. Lippold
258 Park Square Bldg., Boston 16, Mass. HA 6-4639
5 Spring St., Riverside, Conn. Old Greenwich 7-2210
New York 17, N. Y. — Richard Y. Fuller
1613 Graybar Bldg. MUrray Hill 5-3779
Philadelphia, Pa. — Oscar Wilds
1235 Jericho Road (Abington, Pa.) Ogontz 6843-W
Pittsburgh 19, Pa. — James B. Tafel
404 Frick Bldg. COurt 1-4878
Cleveland Heights, O. Richard M. Ward; F. Allen Schmidt
2945 Fairmount Blvd. FAirmount 1-0616
Chicago 3, Ill. Walter Painter; Warren F. Saas
110 S. Dearborn St. DEarborn 2-5446
Detroit 1, Mich. — Richard M. Ward
2230 Park Ave., Room 7 WOodward 5-2268

McDonald-Thompson offices: Seattle 4, Wash., Harry Abney, 1008 Western Ave., Elliott 3767; San Francisco 3, Cal., Les Meek, 315 Market St., YUkon 6-0647; Los Angeles 5, Cal., Connie J. Crabb, 3727 West Sixth Street, DUnkirk 7-5391; Denver 2, Colo., Robert Heidersbach, 222 Colorado National Bank Building, Keystone 4-4669; Houston 6, Texas, Frank Vickery, Room 214, 3214 Montrose Blvd., LYnchburg 6711.

Subscription Information: Published monthly; price in the United States and its possessions $10, in Canada $11, in other countries $12 per year; single copies $1.00.

Micro film edition $4.75 annually from University Microfilms, Inc. Ann Arbor, Mich. All volumes since 1948.

Indexed in the Industrial Arts Index and the Engineering Index on file in public and many private libraries.

Copyright 1954 by Technical Publishing Co. Acceptance under Section 34.64 P. L. & R., authorized publication office at Concord, N. H.

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

neers and director of D. & C. and William Press, accompanied by D. Holmes, of D. & C. and William Press, and by L. Clark, development engineer, North Thames Gas Board, have visited the United States and W. L. Morrison at Lake Forest, Illinois.

• • •

HARRY ENGVALL, formerly chief engineer of the Turbine and Gear Departments of the De Laval Steam Turbine Co., has been promoted to the post of executive engineer. His former duties have been assumed by John S. Haverstick.

• • •

VITRO CORP. of America, long active in atomic energy, has entered the field of uranium mining. Vitro has acquired an interest in 57 uranium claims from the Sateco Mining Company in the Gas Hills area of Fremont County, Wyo., and has commenced exploration and drilling in preparation for mining of ore.

• • •

EQUIPPED WITH MINE detectors, United States Marines from Camp Lejeune, N. C., have literally been seeking buried treasure at the site of the International Nickel Co.'s sea-spray corrosion test lot on the Atlantic at Kure Beach, N. C. The Marines were assisting in the search for thousands of valuable specimens torn by Hurricane Hazel from racks 80 ft from the ocean and buried deep in the sand by wind and waves that reduced the area to a shambles.

• • •

CLAUDE M. SMITH, formerly with West Penn Electric Company, and also former utilities specialist for Price & Waterhouse, has joined the Fluor Corporation, Ltd. as Manager of Sales — Utilities.

• • •

ERNEST HARTFORD has retired as deputy secretary of the ASME after 43 years of service to that organization. He will continue to serve the Society in a consulting capacity.

Since 1911, when he joined the Society as assistant to the secretary, he has supervised the ASME staff, society meetings, Professional Divisions, society awards, student branches, admissions, membership development, honors, various awards and the Educational Committee. He is credited by ASME leadership with making a major contribution to the almost tenfold growth of the organization, to a membership of approximately 40,000, with 80 active sections and 135 student branches.

The ASME is going to miss him.

• • •

AS OF November 1, 1954, Wayne Palmer, for many years in charge of power facilities at the South Chicago Works of U. S. Steel Corporation, will be with Pioneer Service and Engineering Company at 231 S. La Salle St., Chicago, Ill. His place at U. S. Steel will be taken by George H. Krapf.

• • •

HAROLD W. COLLINS, general superintendent of Detroit Edison's electrical system since 1945, was promoted to the position of special assistant to the company's Manager of Engineering, Howard P. Seelye.

Delmar D. Chase has been moved up from assistant superintendent to General Superintendent of the Electrical System, and will assume Collins' former duties.

F. Clifford Pohl has been named to take over Chase's previous assignment, and Ernest W. Spring, former staff assistant, will replace Pohl with the title of Superintendent of Electrical System Equipment.

Detroit Edison also has announced the appointment of Howard R. Stevenson, former assistant manager of sales, as assistant manager of operations. He will report to Operations Manager W. W. Williams.

• • •

CHARLES A. SCARLOTT, former editor of "Westinghouse Engineer," has recently joined the Public Relations Department of Stanford Research Institute as manager of technical information services. He has been an editor in the engineering field for over twenty years, has specialized in the field of energy, and is co-author with Eugene Ayres of a book entitled "Energy Sources" published by McGraw-Hill in 1952. He has also co-authored other books on "Electronics for Industry" and "Fundamentals of Radio."

• • •

H. D. EMMERT has been appointed assistant chief engineer of Allis-Chalmers steam turbine section, power department. Emmert joined the graduate student training course at Allis-Chalmers in 1937 after receiving his mechanical engineering degree from Georgia Tech. Since that time he has been associated with steam turbines and similar equipment.

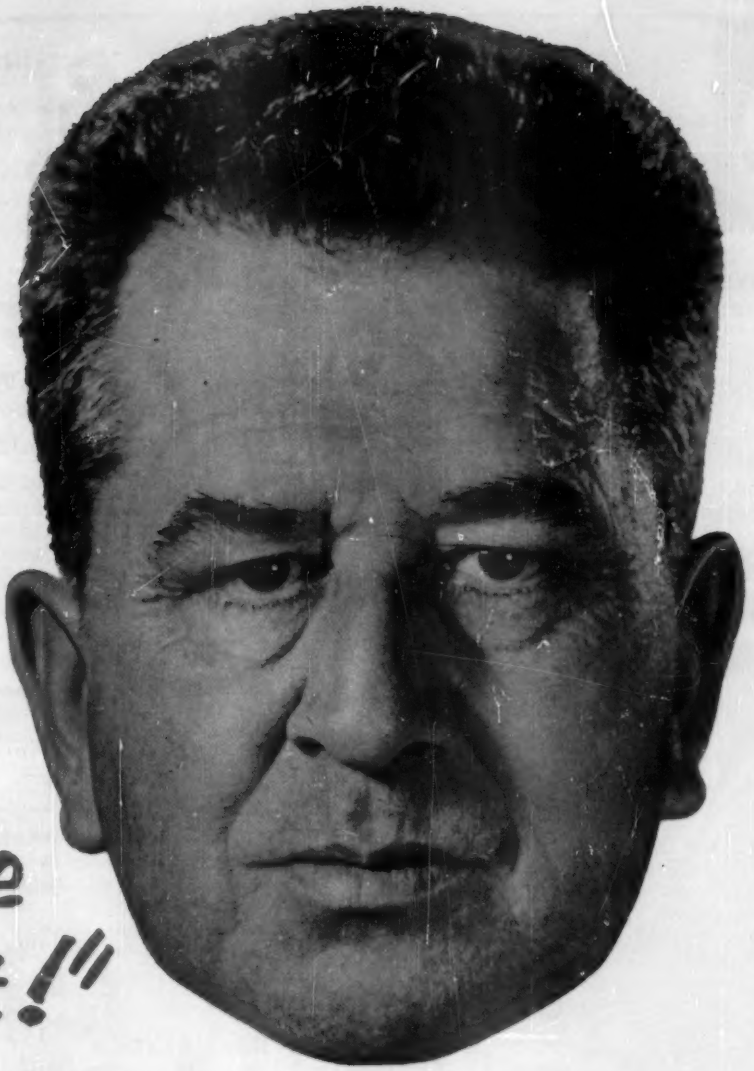
In 1951 he was given charge of the turbo-prop engine section, a post held until early 1954 when he became engineer-in-charge of development for the steam turbine section.

POWER ENGINEERING Reprints Available

WE HAVE on hand a small supply — 50 to 100 copies — of each of the following articles published in POWER ENGINEERING in 1954.

How to Figure Performance Curves for Your Liquid Jet Pump	January 1954 issue
Pipe Sizing Charts	February 1954 issue
Sara Keeps Watch at Three TVA Steam Plants	February 1954 issue
How to Splice a Wire Rope Thimble	March 1954 issue
Feedwater Chemistry Relations	March 1954 issue
144 Ways to Parallel Transformers	March 1954 issue
A-C Generators in Parallel	April-May 1954 issues
Figuring Combustion Air-to-Fuel Ratios	May 1954 issue
Natural Gas to be Liquefied and Transported by River Barge	June 1954 issue
Masonry Drilling, (4 Articles)	June, July, August, September 1954

If you want a copy of any of these reprints, as long as our supply lasts, write the Editor or note the title on one of the postage-free return postal cards elsewhere in this issue and mail it to us. One copy to a customer as long as they last, without charge and with our compliments.



"33,000 HOURS proved the choice was right!"

When a prominent North Carolina community converted its power plant to diesel operation, it called in Sinclair Lubrication Engineer Jim Holt for his recommendations on proper lubricants.

Mr. Holt reports, "I recommended Sinclair RUBILENE®. My previous experience convinced me that this diesel lubricating oil would provide maximum wear protection for this power plant's six 1000 K.W. diesel engines. RUBILENE also guards against sticking rings and prevents excessive wear of cylinders, pistons and other moving parts operating continuously for long periods.

"RUBILENE was the right choice," Mr. Holt continues. "After 33,000 hours of near-continuous operation, bearings show very little discernible wear – and there's not a sign of erosive or corrosive action. *Oil consumption is remarkably low,* considering the prolonged operating hours under overload. All six 1000 K.W. engines, with a total output of 6400 K.W. per hour, *use a total of only 1 barrel of oil a day!*"

Why not give a Sinclair Lubrication Engineer the chance to help solve *your* lubrication problem. *There's no obligation.* Contact your local Sinclair office or write Sinclair Refining Company, 600 Fifth Avenue, New York 20, N.Y.

SINCLAIR DIESEL LUBRICANTS

For more data circle 503 on Post Card

HERE'S WHAT THEY TELL US

EVERY WEDNESDAY evening following the New York Times broadcast of News Items, "Meet the Engineer" comes over Station WFLN (FM), Philadelphia. We hope that our Philadelphia readers were listening on December 15th when **Editor Andrew Kramer** discussed Radioactive Aspirin . . . don't miss his second broadcast on Atomic Power scheduled for a later date.

"Meet the Engineer" is sponsored weekly by the Philadelphia Section of the American Institute of Electrical Engineers. Chairman, Radio Committee **T. H. MacCauley,** invited Editor Kramer to appear on the program following publication of his November 5th *Atomics* which carried the discussion of biological uses of radioactive materials.

At the invitation of **Bob Elson,** WCFL, Chicago, our editor gave a guest interview at 3 P.M., December 1, in the Pump Room of the Ambassador East. His comments then were concerned with the preservation of the country's first atomic reactor built in 1942 at Stagg Field, University of Chicago, and later removed to Argonne Woods.

The next day, December 2, Editor Kramer was asked to prepare a film for WBBM to be televised that evening on **John Harrington's** news program. An inspection tour of the historic reactor was made with a brief discussion of its operation. Purpose of the program, televised at 10:30 P.M., was to emphasize the importance of keeping the reactor as a memorial to Dr. Enrico Fermi.

. . .

FRANK M. KECKS, Pittsburgh, Penna., Superintendent, Power Plant, Power Plant Construction, Carnegie Institute of Technology, was grateful for the article in November POWER ENGINEERING entitled Practical Advice on Coal Storage for Industrial Power Plants by Charles H. Marks. Mr. Kecks wrote:

> The article on page 90 came to us at a time when we were beginning to experience hot spots in our coal storage bin. Our coal suppliers could not understand the reason for this and I would like to supply them with a copy of that article.
>
> Do you have tear sheets, or could you supply us with an extra copy of the issue? The article explains fully what has happened to us, and how it may be corrected.

We were pleased to duplicate the issue which arrived at that propitious moment.

. . .

ONE OF OUR READERS who thought an error had been made in the article on Steaming Reactors, September issue, *Atomics,* questioned the use of the word "decrease" in the second paragraph. He believed it should have read "increase."

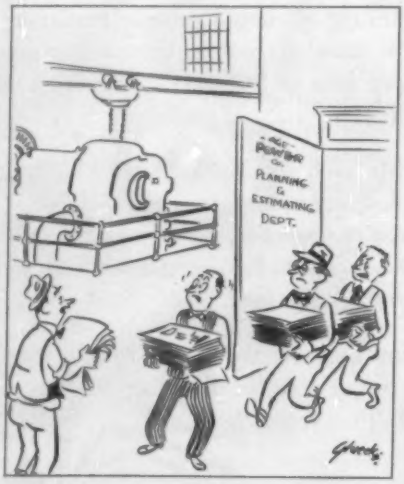
Our editor, who doesn't want anyone to have an erroneous impression of the action of the steam as a moderator, gave the following explanation:

> When the water heats and vaporizes, its density is reduced. The reduction in density reduces its moderating ability so that there is an increase in leakage and non-fission capture. This corresponds to a reduction in reactivity and therefore, a falling off in the rate of heat production.

. . .

ANOTHER READER asked if anyone had made a serious study of the effective life span of nuclear reactors. Editor Kramer replied:

> General Electric, without question, knows more about reactor operation than any other group in the AEC setup. They have been operating the Hanford reactors for some eight years and while several new units have been added, the original ones installed in 1943 are still operating. Indeed, they are in better shape today than when General Electric took over the Hanford plant after the war. I am sure that they have no doubt concerning the life of the graphite moderated water-cooled reactors.



"Oh, I didn't want to put you to any trouble—just wanted a rough estimate"

. . .

RAY N. BENJAMIN, Chief Engineer for Georgia Power Company, Atlanta, who inquired about a reference on page 3, June issue, POWER ENGINEERING, wrote:

> I saw your reference to a pipe line which runs from Cadiz, Ohio to Lake Erie for transporting coal. It seems that the coal is crushed fine, mixed with water, and pumped through the pipe line to effect a considerable saving in transportation cost, as compared with cost of transportation by railroad. If you could refer me to some source of additional information on this subject, I would appreciate your kindness.

Associate Editor Ray Hagenmiller, just back from Ohio, replied:

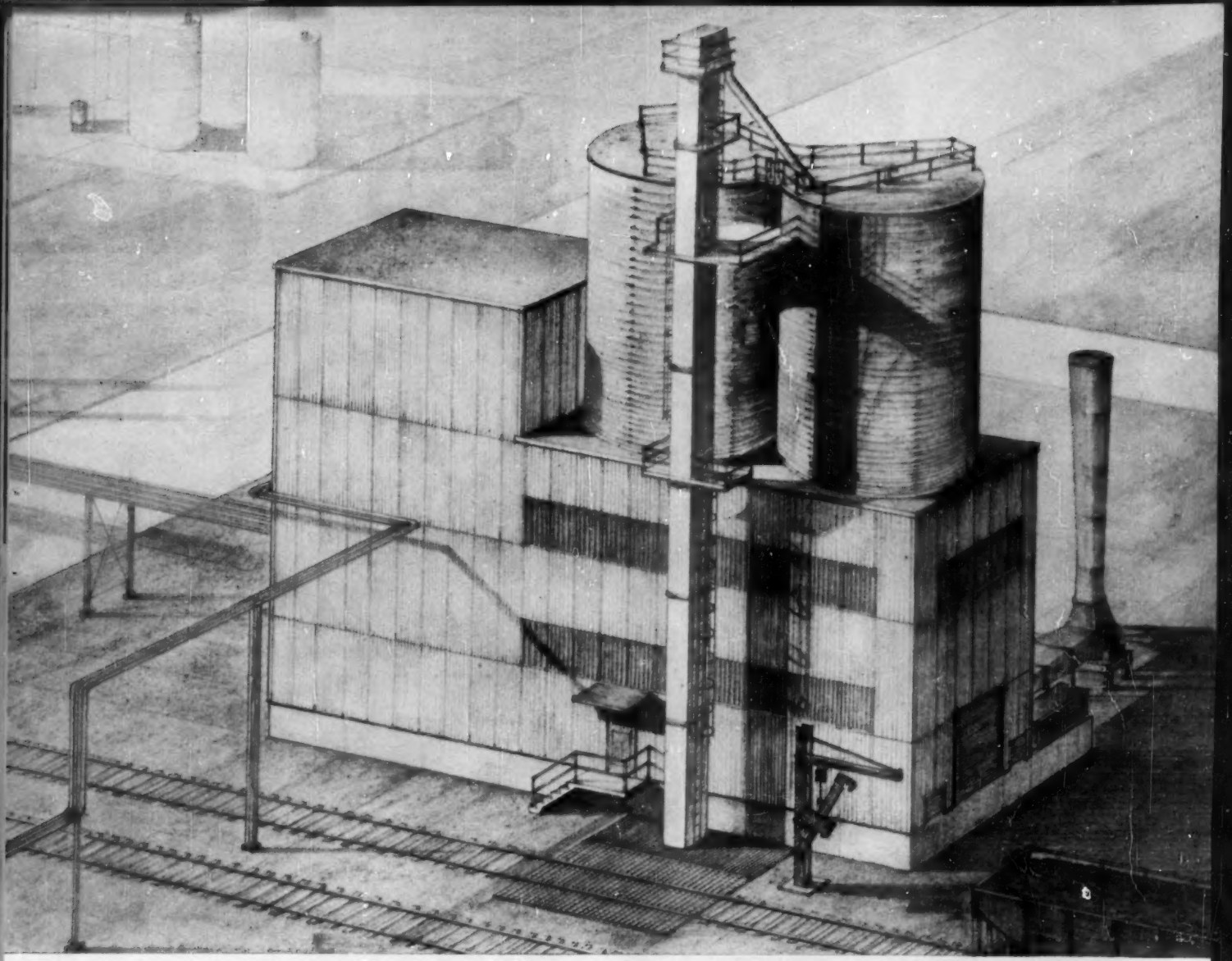
> I find that surprisingly enough, very few people in the equipment business know anything at all about the projected pipe line. However, while in Washington a few weeks ago, I spoke to a representative of the Bituminous Coal Institute. He tells me that this new line has been completely engineered and is only awaiting the signing of the necessary construction contracts. We understand that Joseph E. Purseglove, vice-president in charge of Research and Development, Pittsburgh Consolidation Coal Company, is the man in charge of the development of the project.

. . .

RICHARD H. MORRIS, editorial director of POWER ENGINEERING, was elected first vice-president of the Society of Business Magazine Editors, Washington, for 1955. At the same meeting Norman C. Firth, editor, *Dun's Review and Modern Industry,* was elected secretary-treasurer; Eldridge Peterson, editor, *Printer's Ink,* second vice-president; and Frank P. Tighe, editor of *Motor Age,* was elected president. Also elected to the Executive Committee were Richard C. Lurie, editor, *American Exporter,* and Colin Carmichael, editor, *Machine Design.*

The SBME is a national professional organization of senior editors of 150 professional and technical magazines with a total circulation of over 2,500,000. Its purpose is to promote high editorial standards and help industrial magazines better serve their respective fields.

The symbol of the Society, the Circle and Quill, appears on the masthead of POWER ENGINEERING.



Stauffer Chemical's New Petrochemical Plant Burns Coal the Modern Way

When Stauffer Chemical Co. constructed a multi-million dollar Petrochemical plant in Louisville, Kentucky, the Process Engineering firm of Singmaster & Breyer specified and built a modern coal burning boiler plant (shown above)—incorporating a fully automatic combustion system, completely up-to-date coal and ash handling equipment.

The results? Fuel and labor costs are at a minimum. Dust concentration is well within the limit fixed by the Louisville Air Pollution Control Commission. Initial cost of the plant was $6.38 per pound of steam per hour, compared to an average $8 to $10 for plants the same size. And total cost of steam—including fuel, labor, maintenance, power, and fixed costs—is only 60c per 1000 pounds!

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Talk to a consulting engineer or your nearest coal distributor. Their advice may save you thousands of dollars each year.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can cut your labor cost to a minimum.

Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

BITUMINOUS COAL INSTITUTE
A Department of National Coal Association
Southern Building, Washington 5, D.C.

For more data circle 504 on Post Card

"this is

● Engineers tell us Yarway Remote Liquid Level Indicators are the most dependable boiler insurance they can have.

Instant . . . accurate . . . brilliant . . . continuous readings of boiler water level are seen on the panel or wherever you wish in your plant. You know the readings are right because they are controlled by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. *Indicating mechanism is never under pressure.*

Yarway Indicators may be equipped with a Yarway Control Unit that operates Remote Hi-Lo-Alarm signal lights or horns. For a 24-hour record of boiler water levels, use the Yarway Hi-Lo-Graph Recorder.

On the boiler drum itself you'll want Yarway Water Gages . . . and these "bright as a star" gage readings can now be televised with a Yarway—RCA Television chain.

From drum to panel and at all remote locations, Yarway equipment gives you the safest boiler protection you can buy . . . proved beyond doubt in thousands of power plants.

Write for the specific bulletins you want.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

NEW! WIDER VISION!

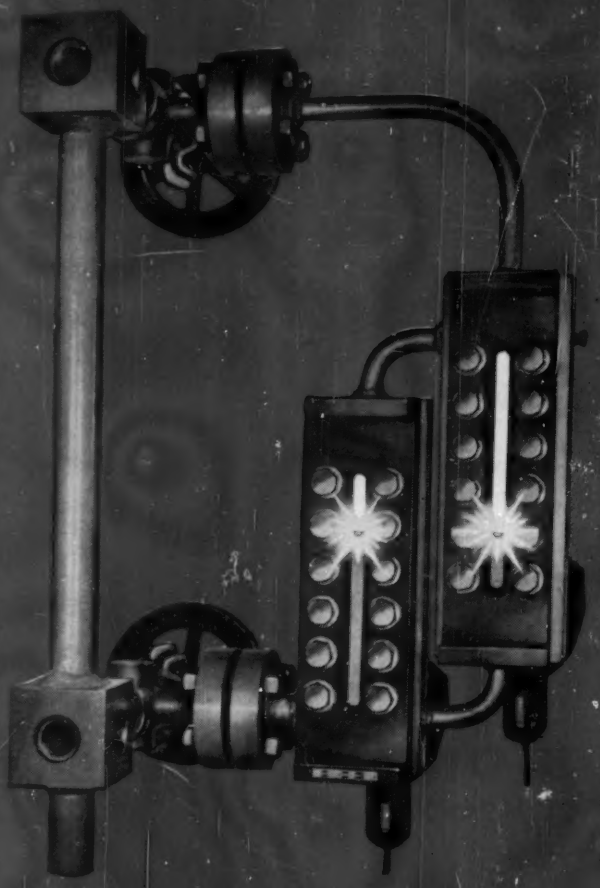
Clear, brilliant readings from any angle, are possible with the new "wide vision" face on the Yarway Remote Liquid Level Indicator. Pointer is always visible, even at extreme high and low water levels.

The Yarway Indicator is manometric type with automatic temperature compensation, as approved for use under the ruling of A.S.M.E. Boiler Code Committee in Case #1155.

Described in Yarway Bulletin WG-1824.

YARWAY®

good boiler insurance!"



YARWAY WATER GAGES

Flat glass, high pressure type shown, features new separated-design insert and Type "M" illumination that causes water level meniscus to "shine like a star". Described in Yarway Bulletin WG-1812.

YARWAY REMOTE SIGNAL ALARMS

Lights on horns, operated by Control Unit on Yarway Indicator, give instant warning of any serious deviation from normal water level. Can be located anywhere in plant. Described in Yarway Bulletin WG-1824.

YARWAY HI-LO-GRAPH RECORDER

Gives a continuous 24-hour record of liquid levels. Actuating mechanism is same as in Yarway Indicator. Used both for indicating and recording. Described in Yarway Bulletin WG-1830.

YARWAY RCA TELEVISION

Simplified system consists of compact camera and panel-mounted monitor. Clear, bright image of water level gage anywhere in the plant.
Described in Yarway Bulletin WG-1813.

steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
LIQUID LEVEL INDICATORS
EXPANSION JOINTS
STEAM TRAPS
STRAINERS
SPRAY NOZZLES
DIGESTER VALVES

For more data circle 505 on Post Card

"Build us a Long Retract..

this was the problem

Designers have talked of boilers 60 or more feet wide, but it had seemed impossible to clean them. Now this problem has been solved by the Vulcan long retract shown at the right. With two entering the furnace from opposite sides, boilers larger than have ever been built can be cleaned dependably.

THIS Vulcan long retractable soot blower has been thoroughly tested. It has dual electric-motor drive. It has the double-helix cleaning pattern that has made Vulcan the standard for effective cleaning of furnaces up to 50 feet wide. Yet, for all its length, it is compact. It is easy to install, operate and maintain. With this new T-30, Vulcan is ready to clean your most modern boilers, no matter how large or how small they might be.

COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE 4, PENNSYLVANIA

VULCAN Automatic

. and we do mean Long"

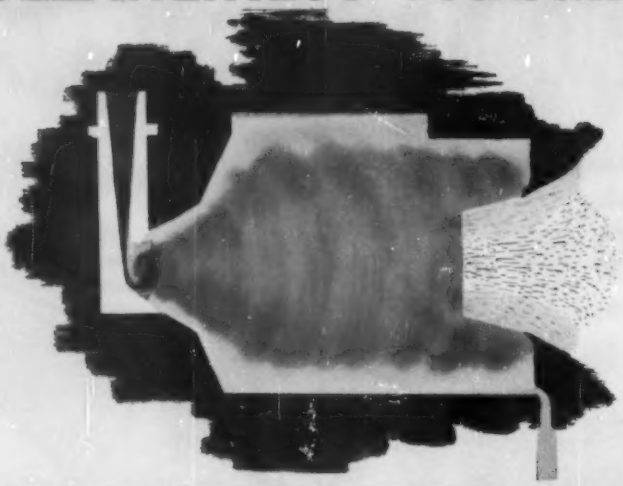
VULCAN
KNOW-HOW
COSTS MORE
—But is Worth it

Soot BLOWERS

For more data circle 506 on Post Card

WITH STACK CLEANLINESS PARAMOUNT...

EASTMAN KODAK SELECTED A



B&W CYCLONE FURNACE BOILER

Faced with all of the problems common to power generation — fuel quality, fly-ash handling, unit availability, initial cost, maintenance cost — Eastman Kodak also has had to give major attention to the all-important factor of cleanliness at its Kodak Park Works. Absolute cleanliness is essential to the manufacture of sensitized paper and photographic film to maintain Kodak's high standard of product quality. Of equal importance is Eastman's outstanding reputation as a "good neighbor" to the thousands of citizens who have built their homes in the vicinity of Kodak Park.

After a long period of careful study and comparison of various types of steam generation units and firing methods — including many visits to utility and industrial power plants—Eastman Kodak engineers chose a B&W Pressurized Cyclone Furnace Boiler.

Here are some of the facts you will want to consider about the Cyclone Furnace:

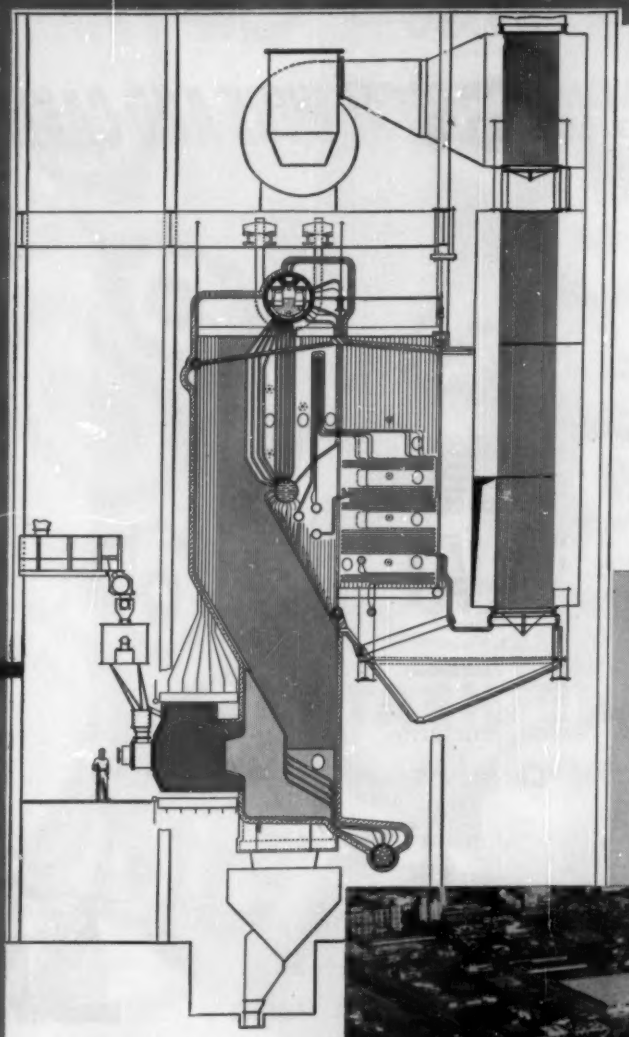
FLY-ASH ELIMINATION—The Cyclone's ability to melt most of the ash to slag in the furnace, holding fly-ash emission to an extremely low level, is vitally important. And with the use of collectors, the small amount of ash that escapes initial melting can be returned to the furnace and converted to readily disposable slag. In addition to cleanliness, this elimination of fly-ash represents substantial savings in ash control, handling and disposal.

SAFER OPERATION—With far fewer burners to light and very fast ignition, the Cyclone Furnace is safe, simple and easy to operate. Combustion controls are greatly simplified.

BURNS A VARIETY OF FUELS ECONOMICALLY—Designed to handle efficiently a wide range of coals including the poorer grades, the Cyclone Furnace is also ideally suited for burning oil or gas. Because it can be switched from fuel to fuel almost instantaneously, no time is lost and advantage can be taken of fuel price fluctuations.

LESS MAINTENANCE—As there are no pulverizers with motors, fans, ducts, and piping, and as there is so little ash in the flue gas to cause abrasive wear, maintenance is reduced, even when normally troublesome coals are burned.

Eastman Kodak is the most recent addition to the mounting list of large industrial and utility companies to turn to the cost-saving advantages of the Cyclone Furnace. B&W's technological knowledge gained through development of and experience with the Cyclone Furnace and many more major engineering advances in steam generation, is available to you at any time. The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N. Y.



B&W Pressurized Cyclone-Fired Radiant Boiler to be installed in the latest addition to Eastman's Kodak Park Works Power Plant, Burns & Roe, Inc., Engineers. Equipped with two Cyclones, the unit will generate 400,000 pounds of steam per hour and will burn coal or oil. Design pressure is 1575 psi. Pressure at the superheater outlet is 1425 psi, temperature is 900 F.

BABCOCK & WILCOX

BOILER DIVISION

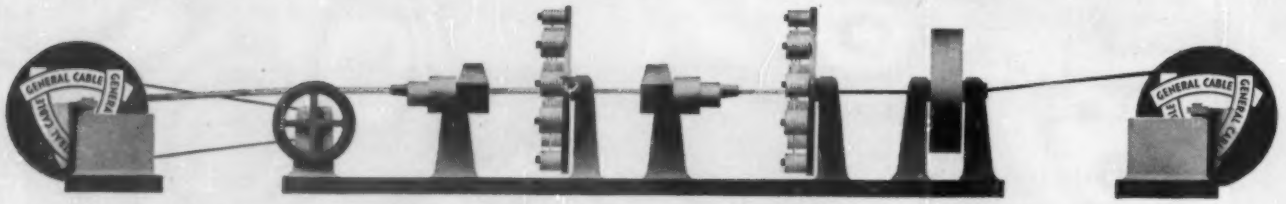
G-650

For more data circle 507 on Post Card

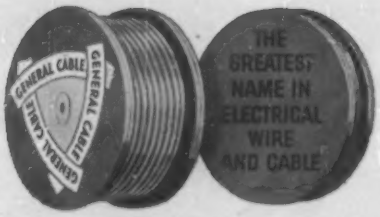
THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE

BEAT THE HEAT

on electrical wires and cables at lower cost



With All-Asbestos and Asbestos-VC



BARE, WEATHERPROOF, INSULATED WIRES and CABLES FOR EVERY ELECTRICAL PURPOSE

General Cable All-Asbestos and Asbestos-Varnished Cambric wires and cables provide safe, sure wiring for power, control, apparatus leads and switchboard installations. Especially where heat is a factor or when resistance to flame, oil, grease or corrosive fumes is a must.

Better than other types of insulation, All-Asbestos and Asbestos-Varnished Cambric wires and cables permit higher current carrying capacities with the same conductor sizes or the same current carrying capacities with smaller conductor sizes. These wire and cable products are ideal for installation near furnaces, ovens, boilers and in similar hot locations.

STANDARD CONSTRUCTIONS

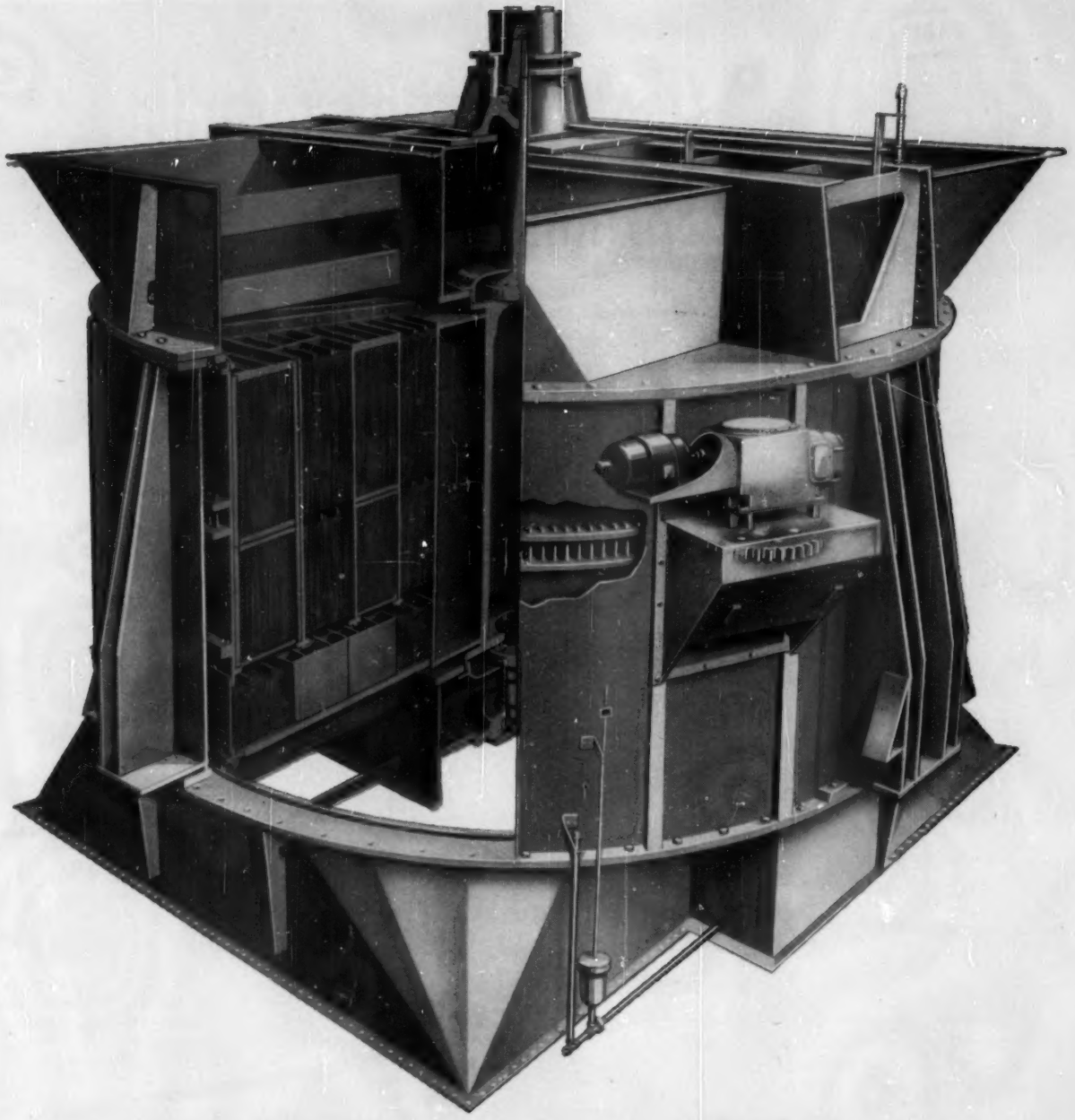
	Insulation	Covering	Conductor
ALL-ASBESTOS	Asbestos	Asbestos braid, or without covering	Solid, stranded, flexible copper or aluminum
ASBESTOS-VC	Asbestos and Varnished Cambric Asbestos and Gencaseal (polyvinyl plastic)	Asbestos Braid Cotton Braid Lead Sheath	Solid, stranded, flexible copper or aluminum

Whatever your wire or cable problem—only General Cable makes and can supply every type you need. For future electrical needs—it pays to *wire bigger* when building new, *wire bigger* when re-wiring, too! See your courteous General Cable Representative today!

GENERAL CABLE CORPORATION

420 Lexington Ave., N. Y. 17, N. Y. • Sales Offices: Atlanta • Boston • Buffalo • Chicago Cincinnati • Cleveland • Dallas • Denver • Detroit • Erie (Pa.) • Greensboro (N. C.) • Houston Indianapolis • Kansas City • Los Angeles • Memphis • Milwaukee • Minneapolis • New York Newark (N. J.) • Philadelphia • Pittsburgh • Portland (Ore.) • Richmond (Va.) • Rochester (N. Y.) • Rome (N. Y.) • St. Louis • San Francisco • Seattle • Syracuse • Tulsa • Wash., D. C.

For more data circle 508 on Post Card



THE LJUNGSTROM AIR PREHEATER

cuts fuel costs in hundreds of plants

The Ljungstrom Air Preheater has proved its value in industrial and utility plants throughout the country. That's why every year, a constantly increasing percentage of the total installed boiler capacity is Ljungstrom-equipped. *Your fuel costs will drop, too,* when you equip your boilers with Ljungstroms. The extremely high efficiency of the regenerative design means the greatest possible recovery of waste heat . . . with substantially lower fuel requirements.

If you are planning a new boiler installation — or expanding or modernizing your present one — let our engineers show you how the Ljungstrom can raise over-all efficiency in your plant.

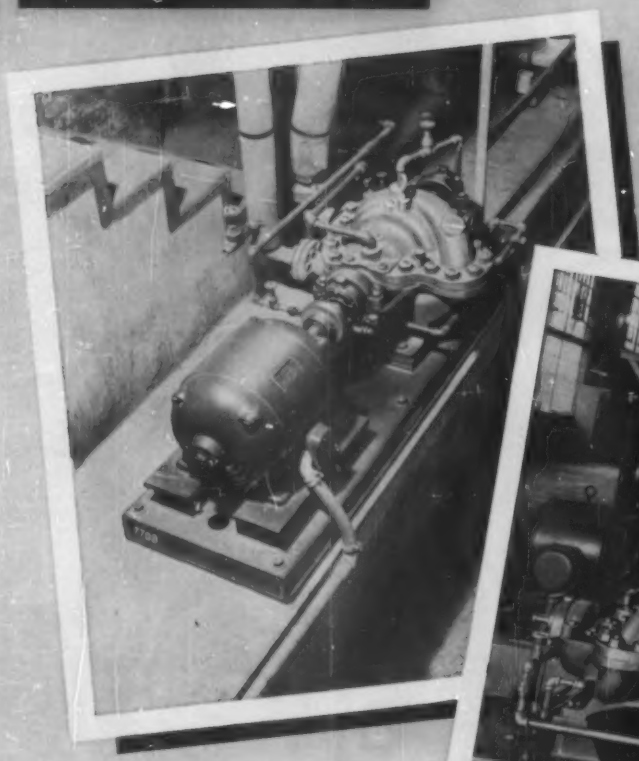
Ljungstrom Air Preheaters are now available for boilers of any type or capacity from 25,000 pounds of steam per hour up.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

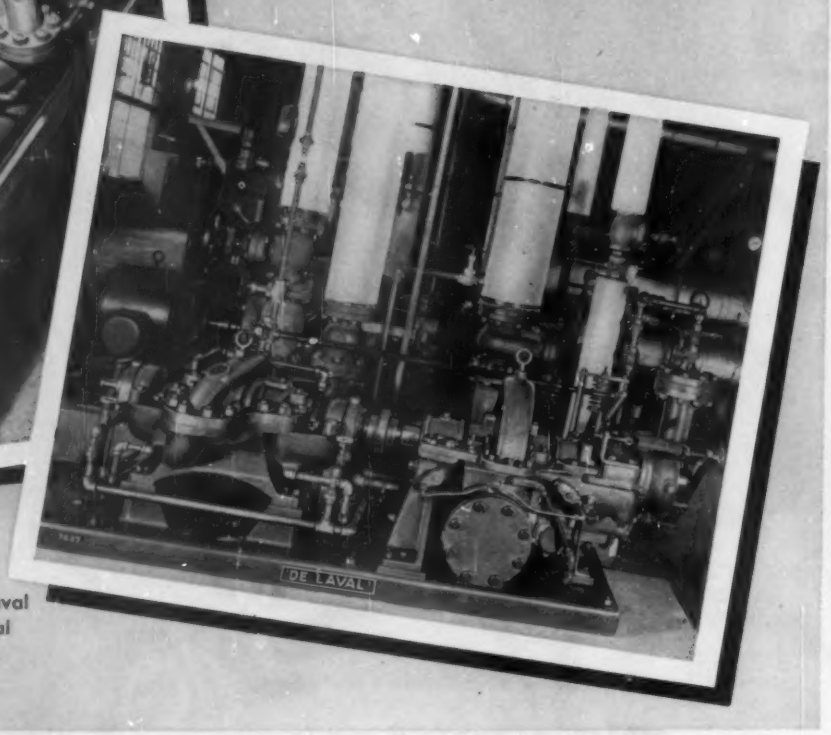
For more data circle 509 on Post Card

DE LAVAL
TWO-STAGE HORIZONTAL PUMPS

for dependable boiler feed service in institutions . . . industrial plants



Institutions can't afford shutdowns. In this hospital installation a motor-driven 21S boiler feed pump provides year-in, year-out dependability. It delivers 70 gpm of 240° water at 420 ft. head.



Industrial plants, too, choose reliable De Laval pumps for boiler feed service. This De Laval unit, driven by a De Laval turbine, delivers 160 gpm of 215° water at 520 ft. head.

There are good reasons why De Laval 21S-2KS two-stage horizontal split case pumps give long, economical boiler feed service. They are designed with • back-to-back impellers for balanced hydraulic thrust • easily replaceable threaded impeller wearing rings • long life labyrinth case rings • ring oiled ball bearings — plus ten other important design features.

These De Laval pumps are available in sizes from 2" to 8" discharge, for capacities from 75 to 3,000 gpm and heads to 750 ft.

Write for Bulletin 1501 giving complete data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY

816 Nottingham Way, Trenton 2, New Jersey

DL 274

For more data circle 510 on Post Card

Nothing like new G-B SNAP-ON glass fiber pipe insulation!

Molded in one piece with single seam. Anyone can carry feather-light 6′ sections. Just spread seam . . . snap over pipe . . . join seam with staple. Paint if you like.

No mud or dust no clean-up time no breakage. Sizes ¾-33″ for hot or cold* piping. Picture the savings. Then write today for samples and details.

Local stocks maintained for immediate delivery in 63 cities.
See Yellow Pages for your nearest distributor.

*Comes with factory-applied vapor barrier facing adhered.

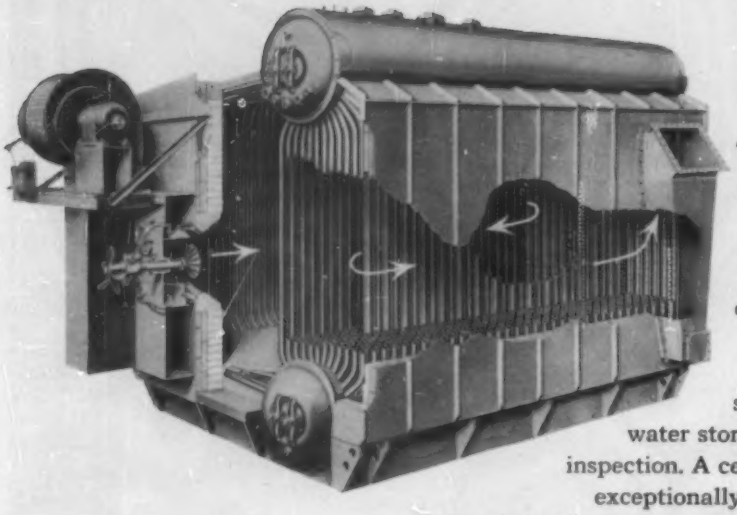
GUSTIN-BACON Manufacturing Company gb

Thermal and acoustical glass fiber insulations • Pipe Coverings and fittings • Railroad gaskets and supplies

250 W. 10th St., KANSAS CITY, MO.

For more data circle 511 on Post Card

STANDARD BOILERS THAT

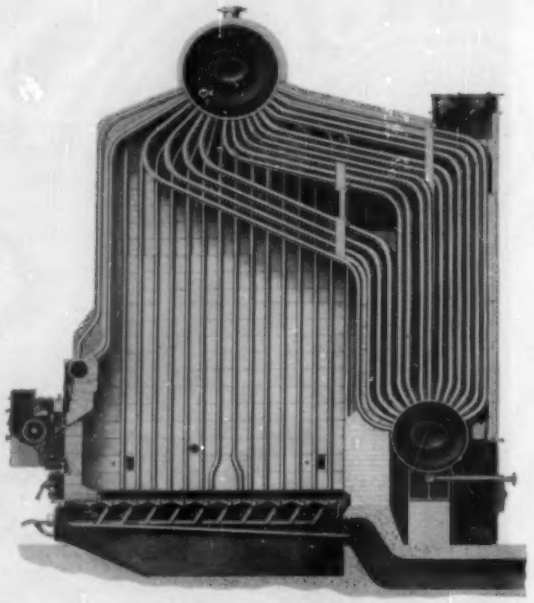


C-E Package Boiler, Type VP

This completely shop-assembled boiler is available in fourteen sizes from 4,000 to 40,000 pounds of steam per hour . . . for operating pressures up to 500 psi . . . for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum — 30-inch diameter — permits a simple, symmetrical tube arrangement . . . greater water storage capacity . . . easy access for washing down or inspection. A centrifugal fan, which operates at low speed and is exceptionally quiet in operation, is standard equipment. The simple baffle arrangement results in low draft loss . . . simple soot blowing . . . no dead pockets . . . high heat absorption. The VP is enclosed in a reinforced, gastight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.

C-E Vertical-Unit Boiler, Type VU-10

The VU-10 is available in nine sizes from 10,000 to 60,000 pounds of steam per hour . . . for operating pressures up to 475 psi . . . superheat to 200 F in 20,000-60,000 lb range . . . for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit — boiler, furnace setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangement of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.



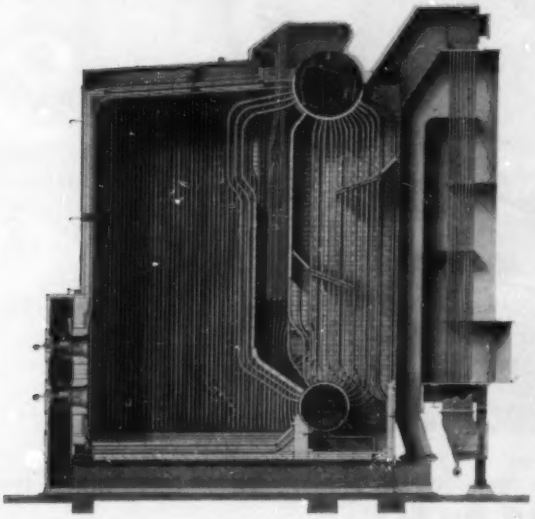
BOILERS, FUEL BURNING AND RELATED EQUIPMENT: PULVERIZERS, AIR SEPARATORS AND

SET INDUSTRY STANDARDS

Whatever your needs for steam may be, in the complete C-E line of fuel burning and steam generating equipment, you will find a type and size just right for your plant.

***In the moderate capacity range,* for example — that is, from 4,000 to 120,000 pounds of steam per hour — the three *completely standardized* C-E Boilers shown here offer advantages of economy and over-all performance that make them standout values in their respective fields of application.**

These C-E Boilers are manufactured for the highest standards of performance, under a wide range of fuel requirements and operating conditions. Yet, because they are so fully standardized, their cost is well within the reach of the industrial budget.



C-E Vertical-Unit Boiler, Type VU-55

The VU-55 Boiler is available in six sizes from 50,000 to 120,000 pounds of steam per hour . . . for operating pressures of 250 psi or 500 psi in each size . . . with superheat and heat recovery equipment if desired . . . for liquid or gaseous fuels. Like the VU-10, this boiler is of symmetrical design, each transverse section being identical with every other section. Thus the gas temperature entering the boiler bank is constant across the full width of the unit. No outside supporting steel is needed, since the boiler is bottom-supported. The basic design for the VU-55 was originated by Combustion in 1925 and has achieved wide acceptance among steam-power engineers everywhere. Its narrow, high furnace . . . integral design of boiler and preheater . . . absence of exterior ductwork . . . and the compactness resulting from modern, coordinated design — all help the VU-55 reach a standard of economic performance closely approaching that obtained in large central power stations.

Other C-E Industrial Boilers

In addition to the standard boilers shown here, the Combustion line includes many other 2-drum designs available for capacities up to 350,000 pounds of steam per hour, which can be designed to burn any commercially available fuel. These units are available for use with pressures up to 1375 psi and steam temperatures as high as 960 F. They may incorporate heat recovery equipment of any type, and can be arranged for difficult space conditions. So — whatever your steam needs — call Combustion for details on the complete line of C-E Industrial Boilers.

B-767C

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

For more data circle 512 on Post Card

Evenly matched or not...

there's enough difference to make all the difference

Before the bout, two fighters may look equally good to the fans. After a round or two, the differences begin to show up.

It's the same with heat exchanger tubes. They all start out looking pretty much alike, but under the test of day-in, day-out operation, Scovill Phosphorized Admiralty Heat Exchanger Tubes have consistently shown superior performance.

Hot-extrusion from Scovill Continuous-Cast billets means uniformity in the metal, uniformity of chemical composition and grain structure, uniformly high phosphorus content. It means sounder metal—smooth, dense, free from pits or porosity. These—plus Scovill's unrivaled Technical Application Services—are, indeed, differences that make *all* the difference in economical, uninterrupted service under tough operating conditions. Let us tell you more about them.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

SSCSS

For more data circle 513 on Post Card

THE DE LAVAL TURBINE OIL PURIFIER TURNS "THUMBS DOWN" ON SLUDGE

Water in a turbine lubrication system, induces sludge formation . . . and sludge is another word for "trouble".

De Laval Oil Purifiers minimize sludge formation by removing the water . . . keeping the oil *dry*.

Furthermore, they remove any sludge and dirt . . . keeping the oil in prime condition . . . extending its useful life . . . while giving the turbine *full* protection.

Bulletin TU-1 gives complete details, as well as helpful diagrams. ***Write for it.***

DE LAVAL

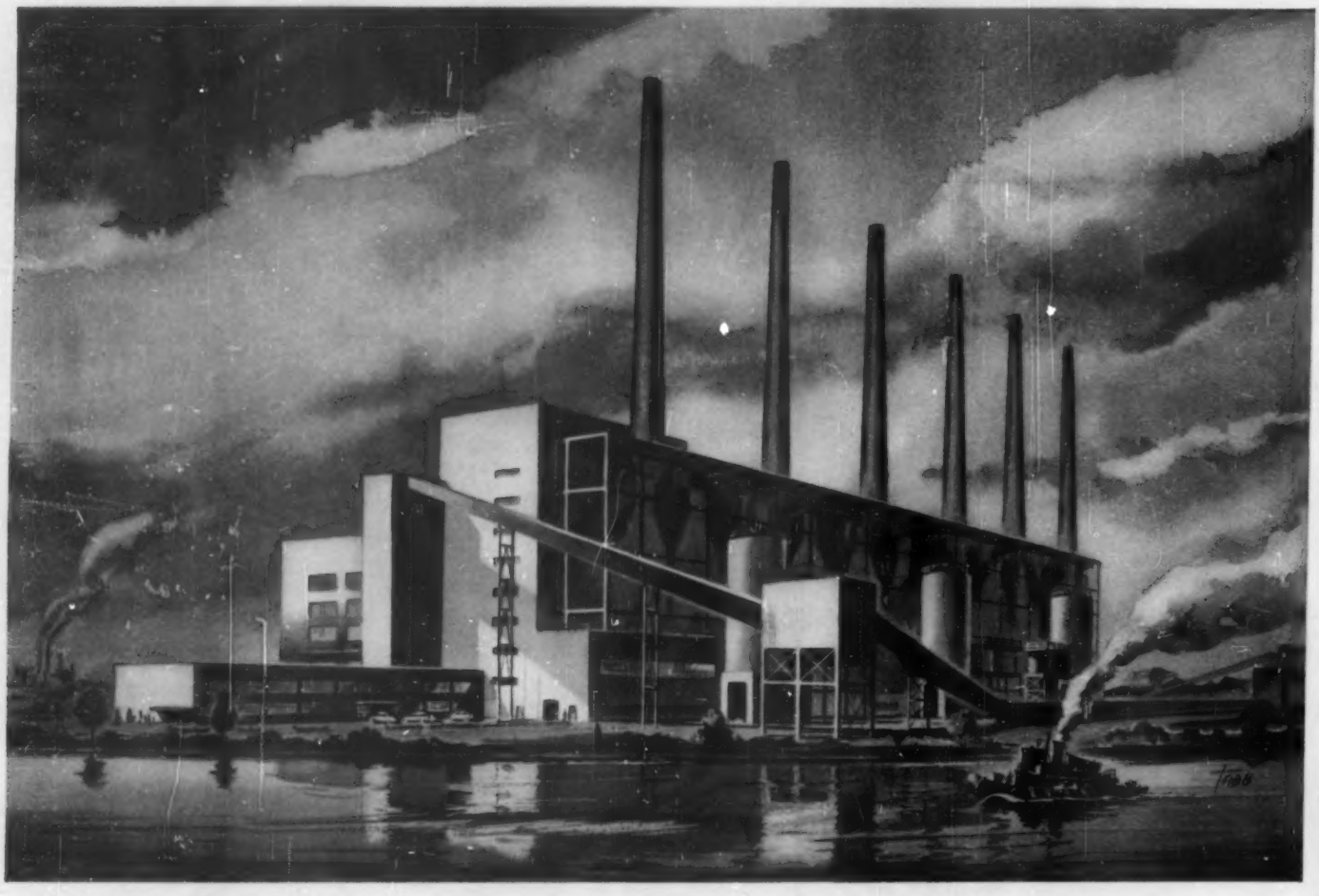
Turbine Oil Purifiers for more Dependable Power Production

THE DE LAVAL SEPARATOR COMPANY Poughkeepsie, New York • 427 Randolph St., Chicago 6 • **DE LAVAL PACIFIC CO.** 61 Beale St., San Francisco 5

For more data circle 514 on Post Card

. . . *and now*

2,000,000



Reddy Kilowatt

3,250,000 KILOWATTS BY 1957

When the new unit goes into operation, capacity of the Detroit Edison system will total three and a quarter million kilowatts—more than double that of ten years ago. This will be the third unit to be installed at River Rouge—the other two, with a capacity of 260,000 kw each, will go on line in 1956.

** Trade mark character used by permission of Reddy Kilowatt, Inc.*

pounds per hour!

Detroit Edison to make power generation history at new River Rouge Plant . . . with a tradition-shattering high-pressure turbine of 300,000 kw capacity, served by a Foster Wheeler Steam Generator, the largest in the world!

IT TAKES COURAGE and foresight to break with tradition—to plan and execute a power project which far surpasses anything ever done before. But the break has been made and a thrilling new chapter in power plant history is now being written. It's the story of Detroit Edison's River Rouge Plant.

Here, late in 1957, the largest steam turbine-generator in the world will go into operation. Rated at 300,000 kw, it will set completely new standards of efficiency and economy—producing a kilowatt of electricity for less than three fourths of a pound of coal!

Steam for the giant turbine will be supplied by a single Foster Wheeler steam generator with a capacity of two million pounds per hour at 2450 psi pressure and 1050 F at the superheater outlet. Reheat facilities will resuperheat the steam to 1000 F after it has passed through the initial stages of the turbine. This, the largest single steam generator ever to be built, represents a great forward step in power plant engineering.

The awarding of this record-making order is therefore a gratifying vote of *confidence* from Detroit Edison. Past achievements show that this confidence is well placed. With more than fifty years of experience in steam generation, and the finest modern manufacturing facilities in three large plants, Foster Wheeler welcomes the opportunity to help Detroit Edison make history at River Rouge. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

For more data circle 515 on Post Card

SMALL PLANTS, TOO!

CAN PROFITABLY USE THE *Nalco* SYSTEM

X-Ray equipment, used in the Nalco Laboratories as an aid toward providing positive water treatment results.

● *Water treatment service for small plants is an important part of Nalco's business.*

This indicates two things:

Small plants find Nalco Service Agreements a profitable investment . . . And

Nalco facilities and services are geared to handle — efficiently and economically — the needs of *any* plant, regardless of its size or the volume of water treatment chemicals used.

If your plant is a small one, you can get the same security from water treatment difficulties as many of the world's largest steam generating stations have with Nalco Service Agreements — and at a cost entirely in line with the size of *your* plant and your problems. Write today for complete details, or call your Nalco Representative.

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario, Canada

THE *Nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

For more data circle 516 on Post Card

HELPFUL BULLETINS

SEWAGE, WASTE HANDLING

101 Sanitary Screening Equipment — Book 2587, 28-pp, describes screening equipment for removal of solids from water, sewage and industrial waste. Gives complete dimension and specification data for four types of coarse screens for removing large solids, and three types of fine screens (with screen cloth) for removal of small solids. Tables to determine proper size unit for handling various capacities are included. Contains over 30 photos of screening installations and information about application. Link-Belt Co.

102 Recovery of Suspended Materials — Technical Publication CS2, 8-pp, discusses Colloidair systems for recovery of suspended materials from process liquors and for waste water treatment. Catalog features factual data on the efficiency of the Colloidair process, flow sheets of typical installations, descriptions of operating principles, and an analysis by types of industries of various applications for the systems. Bulkley, Dunton Processes, Inc.

103 Clean Waters — Publication GEA-6096, 34 pp, stresses the urgency of providing proper sewage treatment and tells how to get it. Contains facts on water pollution, a course of community action to fight pollution, examples of successful campaigns, and methods of maintaining public support. General Electric Co.

ELECTRICAL EQUIPMENT

104 Motor Control Centers — Eight-pp Bulletin 401 explains how Concentrol standardized modular structures concentrate a larger number of motor controls in one complete packaged unit. Illustrations show details of design and construction. Also described and pictured are Concentrol structures in three NEMA types, as well as a fusible combination type. Layout and short circuit application data, as well as dimensions, ratings and specifications are included. Continental Electric Equipment Co.

105 Induction and Torque Motors — Catalog EI-3A, 26-pp, provides a comprehensive reference to company's induction and torque motors. In addition to listing physical characteristics, dimensional drawings and performance curves are also included, as well as detailed electrical specifications in appropriate groupings for induction units ranging from 1/1000 to 1/6 hp, for single, two, and three phase operation, 15 to 400 cycles. Listings for torque motors cover types and sizes for operation under stall conditions and reverse rotation. Electric Indicator Co., Inc.

106 High Voltage Starters — Folder 1060 introduces a line of air-break electric starters for 2200- to 5000-v squirrel cage, wound rotor, synchronous motors. Illustrates starters using a 50,000-kva air-break contactor. Sectional and complete views of three styles are provided. The Electric Controller & Mfg. Co.

107 Rotary, Multipole Switches — Twelve-pp Catalog 8054-IN on rotary multipole switches, contains complete wiring diagrams and contact charts for voltmeter, ammeter, and voltmeter-ammeter switches. Detailed drawings of snap-acting and detent-action switches are included, with handle and panel-mounting data, physical dimensions, special switch information, and electrical ratings. Electro Switch Corp.

108 Polarized Relay — Bulletin GEA-6212 features a high-speed relay "with a memory," describing the functions and operation of company's hermetically-sealed, high-speed, polarized relay for electronic applications. Provides data on ratings, specifications and dimensions. General Electric Co.

109 Variable-Ratio Transformer — This 6-pp brochure describes company's Vernistat, a precision variable-ratio transformer. Fully explains construction and operation of the device and includes performance curves, application schematics in computer and servo systems, specifications of the 60 and 400 cps types, and step-by-step drawings illustrating the combination auto-transformer and potentiometer mode of operation. Vernistat Div., The Perkin-Elmer Corp.

110 Power Transformers — Bulletin 133 is a 16-pp engineering manual on power transformers. Provides detailed physical and electrical characteristics for liquid-filled single- and three-phase transformers from 750 through 10,000 kva. Includes sections on standard accessories, performance data, dimensions and weight, base dimensions, terminal arrangements and accessories. R. E. Uptegraff Mfg. Co.

111 Speed Variators — Bulletin GEA-6180 describes company's new B case speed variator power unit, a packaged, all-electric adjustable voltage d-c drive operating from a-c power. Provides information on design and operating features, ratings and dimensions. General Electric Co.

COMMUNICATION

113 Communication Systems — Six basic manufacturing problems are illustrated and analyzed in this 16-pp booklet on planned plant communications systems. Importance of proper flow of current information for efficient production as well as management control is discussed. Schematic diagrams help clarify problems in inter-departmental communications. Communications systems for materials handling, control, and maintenance control and other functions are described. Some solutions for the dissemination of information are given. TelAutograph Corp.

114 Power Line Carrier Systems — How modern power line carrier equipment can be used in conjunction with power lines to meet increasing communications needs of expanding utilities is told in 12-pp Technical Bulletin E-111. It delves into the advantages and uses of three types of power line carrier equipment — manual simplex, automatic simplex, and duplex. Types of telephone termination services provided for each are tabulated. Equipment components, transmitter, receiver, control units, accessories, are described and specifications are included. Motorola Communications & Electronics, Inc.

115 Telephones at Work — How a large brewery uses a private internal telephone system in controlling quality and integrating complex stages of operation is told in 8-pp Circular 1762. Applications of telephone facilities in controlling processing operations, speeding product distribution and increasing general plant efficiency are discussed. General specifications of telephone equipment are listed. Automatic Electric Sales Corp.

116 Closed Circuit Television — "How to Read a Blueprint at 500 Ft" tells how closed circuit television is applied to achieve effective work coordination and two-way visual communication between widely separated buildings. Folder describes simplicity and functions of "TV Eye," outlines some general applications, and describes accessory equipment for special applications. Engineering Products Div., Radio Corp. of America.

INSTRUMENTS AND CONTROLS

117 Selective Telemetering — A method of securing information about power flow, oil pressure, bus voltage and other values required for remote operation of substations, pumping stations etc. is described in Bulletin ATIC-929, 12 pp. It tells how a compromise can often be made to provide some information continuously while other data is selected when needed by operator. Explains how shared use of telemeter communication channels with supervisory control systems that permit remote control of valves, motors etc., cuts original equipment costs and space requirements and affords shared use of instrumentation. Motorola Communications & Electronics, Inc.

118 Sampling System — A newly developed system for continuous sampling and oxygen measurement of combustion processes is described in Bulletin 703. Points out advantages of system and diagrams component parts. Selection of sampling tube, gas selector units, and other parts is discussed. Arnold O. Beckman, Inc.

The new and revised publications reviewed on these pages offer help on many operating and maintenance problems. To order them, use the Reader Service Cards on pages 103-104

119 Automatic Temperature Control — Bulletin HT-1, 16-pp, discusses automatic temperature control for induction heating equipment. Covers theory, components of induction heaters, selection of control units, requirements for control, temperature, and radio frequency. Contact control and proportioning control systems for induction heating and melting are de-

scribed. Bulletin contains tables on induction heating frequency scale, methods of controlling radio frequency and high frequency induction heating equipment, as well as numerous diagrams illustrating aspects of design and operation. Brown Instrument Div., Minneapolis-Honeywell Regulator Co.

120 Electric Proportioning Control — A new instrument line — company's Series 60 electric proportioning control — is described in 16-pp Folder ND4(7a). Discusses advances in electric control and points out design and operation characteristics of the new unit. Circuit diagrams illustrate main components of three types of controls — proportioning action control, position-adjusting control and duration-adjusting control. Leeds & Northrup Co.

121 Precision Air Control — Eight-pp Bulletin AV 300R illustrates and describes company's Electroaire Valve. Describes all parts and functions of the packaged air control unit, and includes installation photos, dimensional drawings, and specification data. Schematic wiring diagrams are also shown, and details on the explosion-proof model are given. The Bellows Co.

122 Receiver Recorder — A receiver recorder for pneumatic and electric transmission systems is explained in detail in 12-pp Product Specification E12-5. Provides liberal illustrations, application information, operation and engineering data and ordering specifications. Some typical measuring circuits are diagrammed. Bailey Meter Co.

123 Notes on Pyrometry — This article discusses various aspects of instruments for the determination and control of industrial temperatures. Among the topics treated are: factors affecting accuracy of thermocouples; contact pyrometers; effects of heat input and loss on temperature equilibrium in a furnace; partial and total radiation pyrometers; and surface-temperature signals. Tempil Corp.

124 Gas Analyzers — Twenty-pp Brochure 0703–3 contains part-by-part descriptions of the components of combustible gas analyzers and alarms. Installations in varied industries are covered, and a method of designing a combustible gas alarm system is shown schematically. Instruments to protect against most of the known combustible gases and vapors are described. Mine Safety Appliances Co.

125 Time-Pattern Transmitters — Specification 287–1 lists complete specifications for the company's pneumatic time-pattern transmitter unit, an instrument which positions the set point indices of one or more instruments according to a definite time-pattern. Industrial Div., Minneapolis-Honeywell Regulator Co.

126 Control Drive — Product Specification P81–1, 6-pp, describes design and operation features of control drives, which provide remote-controlled pneumatic power for precise positioning of regulating devices through mechanical linkage. Contains schematic diagrams and a table which aids in selecting a drive meeting specific operating and installation needs. Bailey Meter Co.

VENTILATING

127 Ventilating Equipment — A 36-pp guide to selection of propeller fan type ventilating equipment, Catalog 151 includes specifications and installation data on company's propeller fans in portable, tubeaxial, centrifugal, roof ventilator and other types. Detailed illustrations of construction features accent design and performance factors. Case study photos illustrate various installations. Ilg Electric Ventilating Co.

128 Roof Ventilators — Power and gravity roof ventilators are shown in this 8-pp catalog. Contains technical data and capacity ratings with photo illustrations covering company's line of propeller fan, centrifugal, stationary, rotary and ridge roof ventilators and accessory equipment. Penn Ventilator Co.

PIPING, VALVES, TRAPS

130 Plastic Pipe, Valves — This 6-pp bulletin describes tough, corrosion-resistant Dur-Ace plastic pipe fittings and valves. Gives properties of Dur-Ace and includes table showing resistance to more than a hundred chemicals. Standard sizes and pressures of pipe are given, also sizes and prices. American Hard Rubber Co.

131 On Wrought Iron Pipe — Provided in this data sheet are sizes and dimensions for butt-weld and lap-weld pipe. Also describes wrought iron's composition, gives an easy method of identification, reviews official standards to which wrought iron conforms. A. M. Byers Co.

132 Pipe Lines for Petroleum — Bulletin PL-1 discusses the problems involved in transporting liquid petroleum products through pipe lines. First in a series, the 12-pp bulletin describes in general terms, a typical pipe line system, the variables to be measured, and some of the problems of pipe line control. Includes many diagrams to illustrate various aspects of pipe line systems. Minneapolis-Honeywell Regulator Co.

133 Air Motors and Valves — Bulletin SP-50, 28-pp, illustrates and describes dimensions and specifications of company's air motors and valves. Includes 75 illustrations and 27 specifications charts. Dimensional details facilitate application of the air motors and valves to most any operation. Charts also list accessory items. The Bellows Co.

134 Tips on Air Traps — Bulletin 2022 tells how to choose and install air traps for automatic drainage of water from compressed air inter-coolers, after-coolers, receivers, separators and drip points. Also provided are detail drawings, physical data and list prices of company's ball float, inverted bucket and snap-action air traps. Armstrong Machine Works.

135 Steam and Air Traps — Form 5415 provides illustrated information on steam and air traps for pressures to 600 psig, stressing larger capacity, simplicity of operation and economy. Includes capacity data, selection and installation suggestions. Also describes steam specialties for use in low pressure systems. The C. E. Squires Co.

BUILDING MAINTENANCE

136 Got Floor Problems? — "Floors and Floor Problems" is a 24-pp brochure offering an authoritative discussion of floors. Illustrated by photos, drawings and diagrams, it explores various types of floors and their construction, factors entering into their deterioration, and the diagnosis and treatment of floor troubles. Among subjects treated in detail are reasons for deterioration of wood floors and of concrete floors, and the special problems of industrial floors. The Tremco Mfg. Co.

137 Preserving Concrete Floors — How to eliminate concrete dusting and seal concrete surfaces against the effects of food acids, grease, oil and abrasive wear by means of treatment with Stontop is explained in this folder. Tells where to use this treatment and how to apply it, and describes resulting benefits. Stonhard Co.

138 Hard Mastic Flooring — Facts on Permaflex, a mineral and chemical floor compound, are given in this illustrated folder. Lists advantages, and tells performance characteristics of the floor, where and how it should be used. Step-by-step photos show installation procedure, and cost figures are given on a representative installation. Permaflex Products Co.

MATERIALS HANDLING

139 Conveyor Belt Chart — Engineering data for standard conveyor belt constructions is given in this chart and accompanying sheet. Strength characteristics of eight popular ply and material combinations of conveyor belt constructions are provided. Each property is printed on the chart in a different color to facilitate comparison. Properties are expressed in pounds per inch of width, so that total strength of belt may be obtained by multiplying figure from the chart by the width of the belt. Quaker Rubber Corp., Div., H. K. Porter Co., Inc.

140 Hydraulic Derricks — Rugged hydraulic pole-handling mechanisms are presented in illustrated Form 954. Gives dimensions in operating positions and load ratings for big-load models, front-mounted derrick models for light and medium truck use, and models with adjustable and telescoping side legs. General specifications included. American Truck Equipment Co.

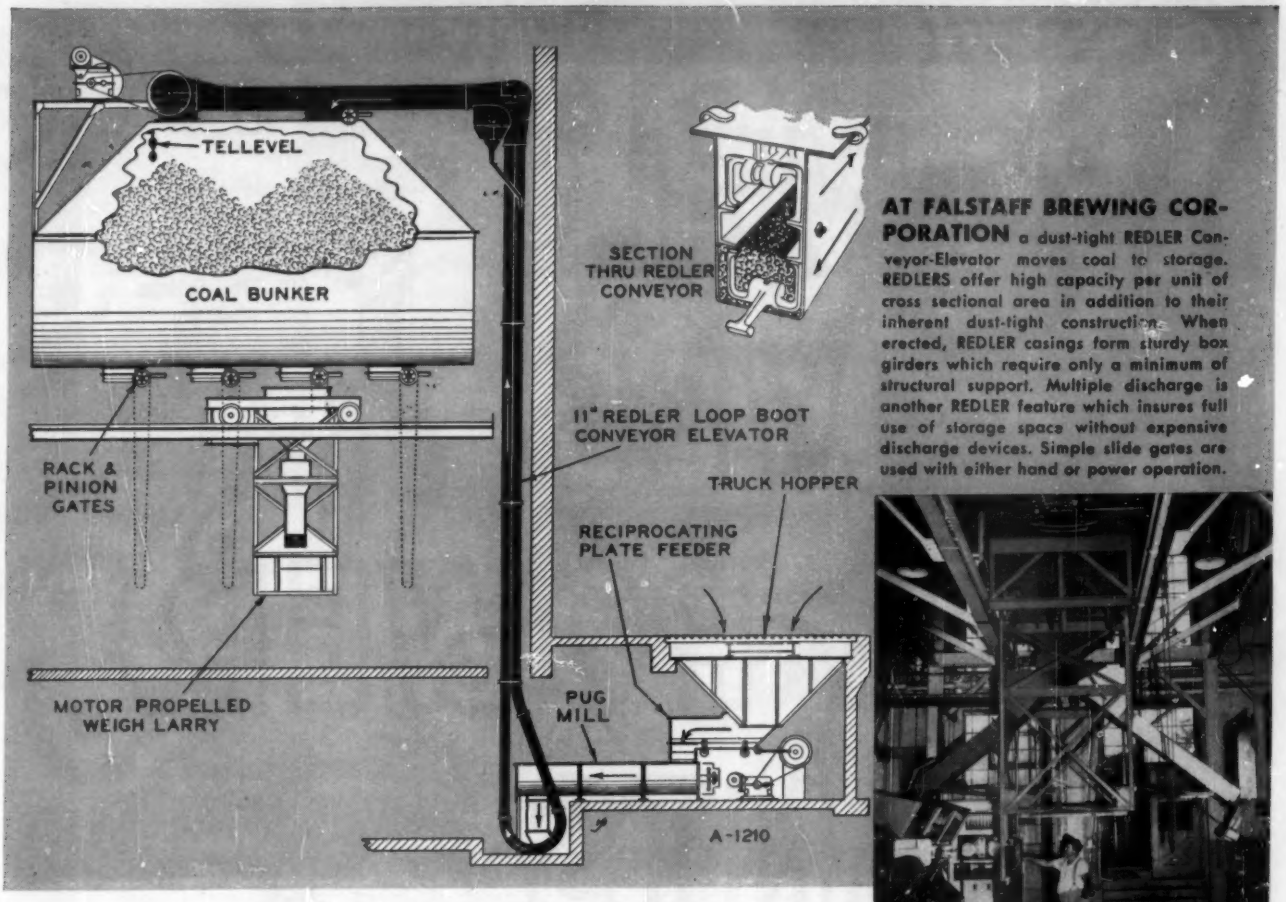
MECHANICAL POWER TRANSMISSION

141 Roller Gear Drives — Twenty-page Catalog 105 describes standard roller gear drives for high speed precision indexing of automatic production machinery. Complete tables on load ratings and dimensions for components only and housed units are given as well as data and instructions for calculation of loads, designing an installation and selection of a drive. Roller Gear Div., Ferguson Machine & Tool Co.

142 Air Clutch — Compact Bulletin A-634 contains information on company's new Air-Grip clutch. Lists outstanding features, explains ease of operation, and provides cross-section drawing showing construction. Besides information on air control and release valves, this bulletin gives tabular data on clutch sizes, bore sizes, also prices. Dodge Mfg. Corp.

143 Full Complement Clutches — Catalog 102 covers company's line of clutches for over-running, backstopping, and indexing applications. Includes photos, application drawings, engineering and specification data for each clutch of the six standard lines. Other sections give specific information on selection, installation and maintenance and the special design service offered by company. Formsprag Co.

144 Cam Clutches — Illustrated Catalog C11–54A, 8-pp, contains general



AT FALSTAFF BREWING CORPORATION a dust-tight REDLER Conveyor-Elevator moves coal to storage. REDLERS offer high capacity per unit of cross sectional area in addition to their inherent dust-tight construction. When erected, REDLER casings form sturdy box girders which require only a minimum of structural support. Multiple discharge is another REDLER feature which insures full use of storage space without expensive discharge devices. Simple slide gates are used with either hand or power operation.

Good Housekeeping Starts with Dust-Free Coal Delivery

From boiler-room to bottling-line, cleanliness is the keynote of Falstaff's brewing process!

A key to the spotless maintenance in this St. Louis plant is a compact REDLER Coal Conveying System. Designed for automatic operation, this completely *sealed* system moves coal from track hopper to stoker hoppers and never gives dust or dirt a chance to escape along the way. In addition to its dirt-free operation, the REDLER System provides important savings in man power. These features, plus meeting of limited space requirements, made a compact REDLER the logical choice on all counts.

If clean handling — of coal or any commodity — in limited space, at low cost per ton is important to you, a REDLER Conveying System will meet your complete requirements. Our engineering department will welcome the opportunity to survey your problem. Use the coupon today.

STEPHENS-ADAMSON MFG. CO.

86 Ridgeway Avenue, Aurora, Illinois
Los Angeles, Calif., Belleville, Ontario

Engineering Division	Specialists in the design and manufacture of all types of bulk materials conveying systems.
Standard Products Division	A complete line of conveyor accessories including centrifugal loaders—car pullers—bin level controls—etc.
SealMaster Division	A complete line of industrial ball bearing units available in both standard and special housings.

Stephens-Adamson Mfg. Co.
86 Ridgeway Avenue, Aurora, Illinois

Please send me your Bulletin No. 140 on REDLER Conveyors.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

For more data circle 517 on Post Card

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL VALVES FOR POWER PLANTS

FIG. 375—Bronze Gate Valve For 200 Pounds W.S.P

FIG. 1793—Iron Body Bronze Mounted Gate Valve For 125 Pounds W.P.

FIG. 19003—900-Pound Pressure Seal Gate Valve

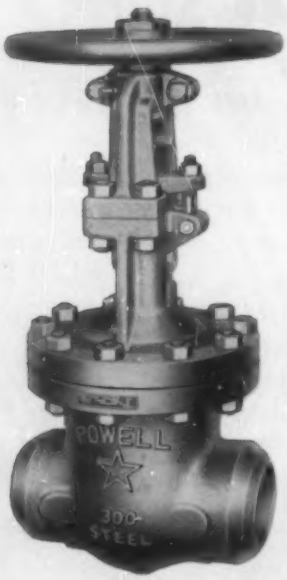


FIG. 3003—Steel Gate Valve For 300 Pounds W.S.P.

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

Just name the valve you need for your power plant—Powell can supply it. And you can be certain that every Powell Valve will give you *dependable* flow control.

Shown above are just a few Powell Valves for power plants. Investigate the *complete* line of quality valves that have a proven record of long life and dependable service.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write . . .

The Wm. Powell Company, Cincinnati 22, Ohio..... 109TH year

For more data circle 518 on Post Card

information on company's cam clutches, including cutaway views, operating functions, line drawings, design features and ordering information. Four illustrated catalog sheets listing specifications, installation procedures and lubrication data accompany folder. Morse Chain Co.

145 Crown Couplings — Bulletin 2203, on crown couplings, includes an illustration showing an exploded view of the coupling and a table containing data necessary to select the correct coupling for a given application. Prices are specified. DeLaval Steam Turbine Co.

146 Moulded Fabric Bearings — This 32-pp brochure illustrates applications and describes properties of moulded fabric bearings, wear plates and other parts. Shows bearings made for grease or oil lubricated, water lubricated, unlubricated and acid resistant services — journal sizes to 48 in. diameter and larger. Also illustrates a great variety of moulded asbestos brake blocks, frictions, cones and other shapes. Gatke Corp.

. . . Outstanding Among This Month's Catalogs

147 For Better Welding — "How to Overcome Your Welding Problems and Improve Your Welding Techniques" is an 8-pp practical manual for those who wish to increase their welding skill and for power engineers who want to gain insight into problems facing the maintenance welder. Covers such matters as the causes of stress raisers, starter cracks and hard spots. Shows, by illustrations, how weld failures can be avoided if consideration is given to joint design to allow for multi-axial stresses. Eutetic Welding Alloys Corp.

148 Flexible Power Distribution — How bus duct meets industry's demand for more flexible power distribution is explained and illustrated in 24-pp Bulletin 300. Connection of 10-ft lengths of duct which can be made from either side, as well as types of tap boxes, end closers and plug-in units employed, are shown. Elbow, tee and cross fittings are also described, as well as transformer taps, flanges and switch board stubs. Complete application and dimensional data plus specifications are included. Continental Electric Equipment Co.

149 Chemical Cleaning of Piping Systems — Advantages of chemical cleaning of service and product lines are outlined in this illustrated bulletin. Shows how chemical cleaning eliminates waste due to inefficient methods, replacement, and describes company's methods of chemical cleaning. Includes case histories of successful cleaning operations. Dowell Inc.

ENGINES

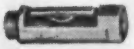
150 Big Power at Low Cost — Twelve-pp Bulletin 235 describes 29-in. bore diesel engines which range in size from 4500 to 10,800 hp. Shows these engines installed in municipal central power stations, public utilities, industrial plants. Points up savings possible from the use of straight run or cracked residual fuels. Photos and cross sectional drawings show construction details. Nordberg Mfg. Co.

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

Expanding scraper and replaceable element.

Expanding brush and replaceable element.

Sectional wire brush.



Air valve for one-man operation.

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

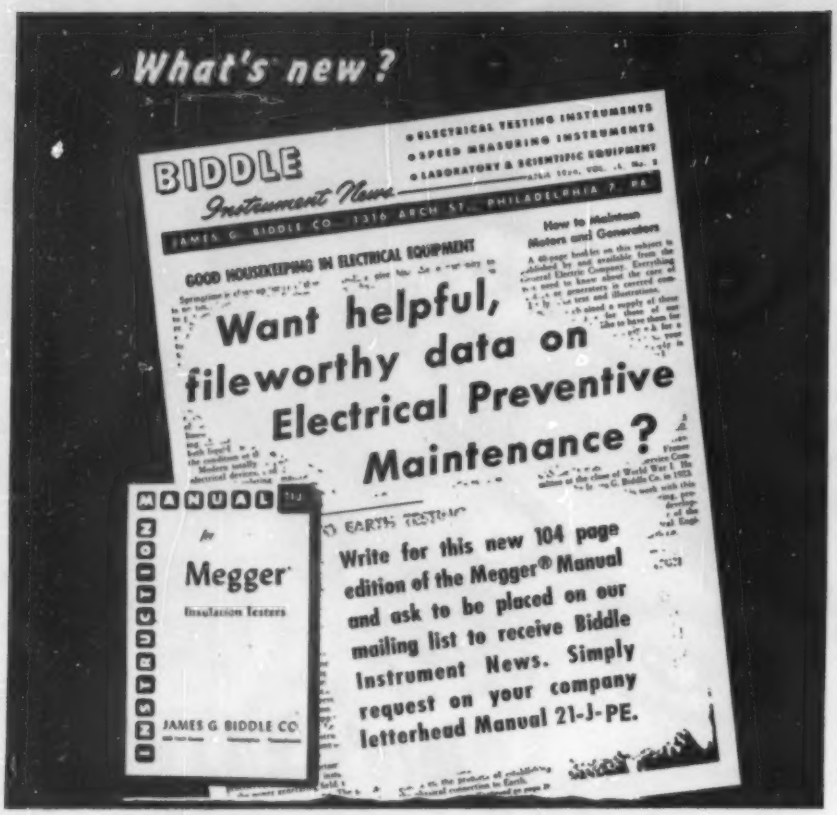
ROTOJET®

Junior TUBE CLEANERS

ELLIOTT COMPANY-ROTO DIVISION

147 Sussex Ave. Newark 1, N. J.

For more data circle 519 on Post Card


What's new?
BIDDLE
Instrument News
JAMES G. BIDDLE CO. 1316 ARCH ST. PHILADELPHIA 7, PA.
GOOD HOUSEKEEPING IN ELECTRICAL EQUIPMENT
How to Maintain Motors and Generators
Want helpful, fileworthy data on Electrical Preventive Maintenance?
MANUAL
for
Megger
Insulation Testers
JAMES G BIDDLE CO.
Write for this new 104 page edition of the Megger® Manual and ask to be placed on our mailing list to receive Biddle Instrument News. Simply request on your company letterhead Manual 21-J-PE.

PARDON OUR POINTING . . .

but we don't want you to miss this NEW BOOKLET on the FRAHM® Resonant Reed Principle of MEASURING SPEED

Parts of the booklet are cut away to show you the simplicity of the inner "works" of a Frahm Resonant Reed Tachometer. *There are no moving parts.* Hence, little or no maintenance is required. Speed is measured by merely touching or mounting a Frahm Resonant Reed Tachometer to any part of the casing or chassis of motor or machine. This is an important *safety* feature because readings do not have to be made in dangerous locations; they may be made at any point that is most accessible and in the best light. The booklet graphically shows you how speed is measured by resonance and read by noting the vibrations of scientifically tuned steel reeds on a scale calibrated in rpm. Many sizes, shapes and models of Frahm Resonant Reed Tachometers are offered by James G. Biddle Company covering speed ranges from as low as 900 to as high as 100,000 rpm. "Every maintenance man can use a Frahm."

Write for Booklet 31-P8-PE.

JAMES G. BIDDLE CO.
1316 Arch St., Philadelphia 7, Pa.

Please mail me ☐ Bulletin 31-P8-PE ☐ Manual 21-J-PE. Thank you.

*Name*_____

*Job*_____

*Company*_____

*Address*_____ 9-433

JAMES G. BIDDLE CO., 1316 ARCH ST.
PHILADELPHIA 7, PA.
ELECTRICAL TESTING • SPEED MEASURING INSTRUMENTS • LABORATORY & SCIENTIFIC EQUIPMENT

For more data circle 523 on Post Card

151 Gas-Butane-Gasoline Engines — Eight-page Bulletin E-7 describes and illustrates 225- to 675-hp engines. Cutaway views and photos point out design features, and charts showing space savings in design and horsepower ratings at varying rpm's are included. Lists basic specifications, areas of application. Le Roi Div., Westinghouse Air Brake Co.

METALS

153 Low Alloy Steels — Sixteen-pp Bulletin A-61 describes a group of high-strength, low alloy steels, giving their characteristics, corrosion resistance, information on forming and working, and design factors involved in their use. Applications in many fields are told, and economics of application explained. The International Nickel Co., Inc.

154 Aluminum Products — This 24-pp booklet contains information on company's aluminum products and services. Discusses characteristics of aluminum, methods of fabricating and finishing, and new alloy designations. Catalog includes data, tables and charts on alloy applications, mechanical and physical properties, extrusions, sheet, plate, and casting alloys. Kaiser Aluminum & Chemical Sales, Inc.

OTHER EQUIPMENT

155 Side Dump Stokers — This 6-pp bulletin points out advantages of company's moving grate side dump stokers, such as their sturdy construction and practical operation. Describes a hydraulically powered and a steam drive unit, and includes photos, diagrams, and specifications. Riley Stoker Corp.

156 Centrifugal Pumps — Bulletin 854, 6-pp, covers six standard models of Impervite impervious graphite centrifugal pumps ranging in size from 25 to 100 ft head. Catalog includes detailed parts drawings, dimensional drawings, and performance charts for each model. In addition, chemical and physical properties of Impervite impervious graphite are listed. Falls Industries, Inc.

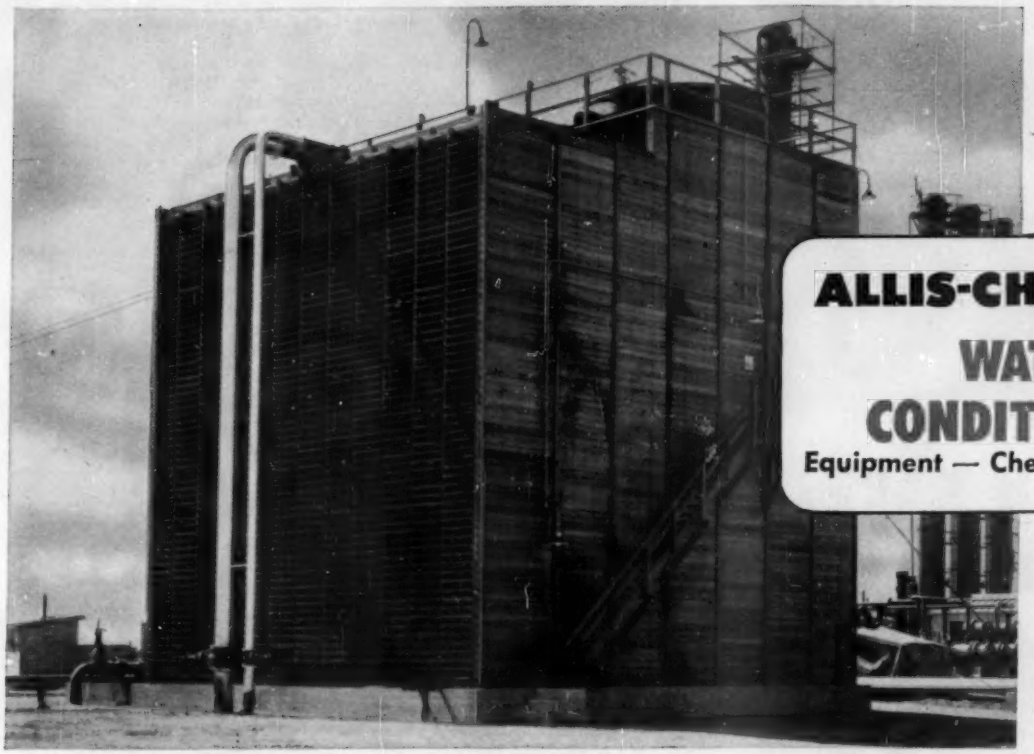
157 Displacement Blower — Operation and application of company's positive displacement blower is described in this bulletin, and full specifications are included. A group of selection charts for standard and heavy duty applications are given, as well as performance curves on a series of blower tests. Read Standard Corp.

It's easy to get these free catalogs—just circle item numbers of those wanted on the two post cards provided on pages 103-104

158 Cooling Water — The dangers of scale and corrosion in cooling systems and organic contamination of cooling system water are outlined in this 6-pp folder. It relates solutions found to cooling water problems in an oil refinery, a steel plant, other industries. Hall Laboratories, Inc.

159 Fluid Power Equipment — Twelve-pp Bulletin 10051-D illustrates and describes company's line of fluid power pumps, motors, transmissions, cylinders

SOLVING WATER PROBLEMS in Cooling Towers



Use of cooling towers to save on water brings unusual problems. Some of these problems are corrosion, scaling, algae and slime, and deterioration of wood in the tower. Allis-Chalmers recently published an informational bulletin, Number 47A, which explains the causes of these problems and what can be done about them.

Part of Practical Library

This bulletin is one of a series published by Allis-Chalmers to help you understand the causes and solutions of many water problems. It is the result of Allis-Chalmers experience solving water problems for every industry, in addition to solving problems involved in the company's own broad line of steam turbine and power plant equipment.

Complete Water Conditioning Service

Allis-Chalmers offers complete water conditioning service. You can get analyses and reports on your problems. You can get chemicals needed in water treatment. And you can get the equipment needed for any system.

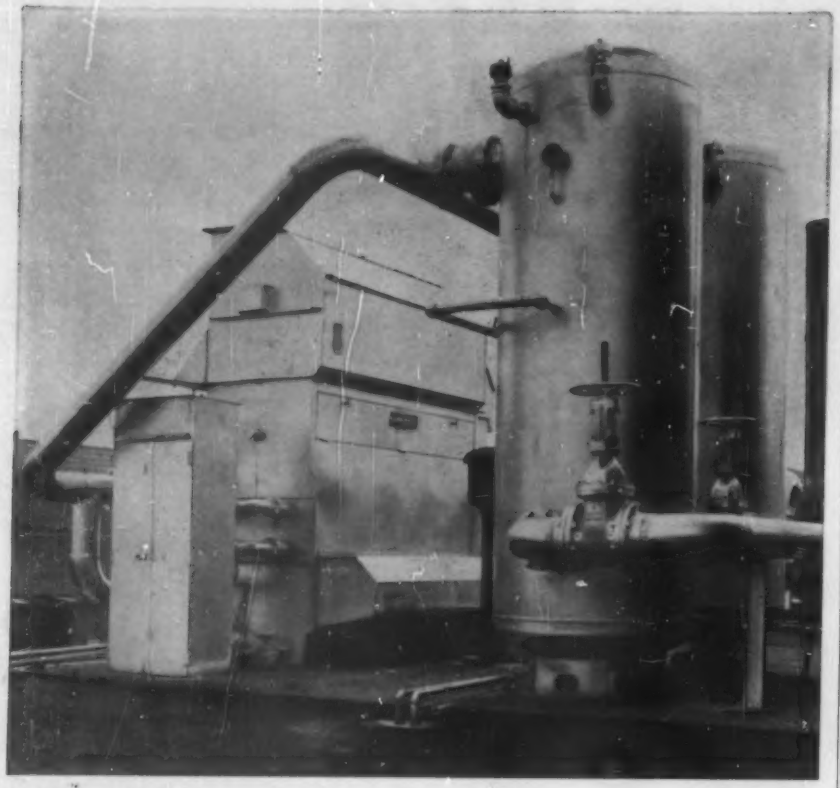
A-4316

Get Information — For your copy of Bulletin 47A on water treatment for cooling towers, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby A-C district office to have an Allis-Chalmers water conditioning engineer consult with you on your problems.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

For more data circle 521 on Post Card



HOW YOU SAVE,

Getting Drier Compressed Air

● Direct saving in the cost of cooling water saves the price of the Niagara Aero After Cooler (for compressed air or gas) in less than two years.

Extra, for no cost, the drier air gives you a better operation and lower costs in the use of all air-operated tools and machines, paint spraying, sand blasting or moisture-free air cleaning. Water saving also means less expense for piping, pumping, water treatment and water disposal, or you get the use of water elsewhere in your plant where it may be badly needed.

Niagara Aero After Cooler assures all these benefits because it cools compressed air or gas below the temperature of the surrounding atmosphere; there can be no further condensation in your air lines. It condenses the moisture by passing the air thru a coil on the surface of which water is evaporated, transferring the heat to the atmosphere. It is installed outdoors, protected from freezing in winter by the Niagara Balanced Wet Bulb Control.

Write for complete information; ask for Bulletin No. 98

NIAGARA BLOWER COMPANY

Dept. E, 405 Lexington Ave. New York 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

For more data circle 522 on Post Card

and valves. Features a new electric-hydraulic servo control system for pumps and transmissions up to 150 hp, a new line of Oilgearducers for constant torque drives. The Oilgear Co.

160 Heat Exchangers — Bulletin HT-40, 8 pp, describes heat exchangers of the shell and tube type for the petroleum and chemical processing industries. Reviews building of the heat exchangers to ASME, API or other specifications and pictures units in various stages of fabrication. A feature of bulletin is a spread of engineering data and drawings of heat exchangers and their basic components. The National Radiator Co.

161 Packing and Sealing Compounds — Self-molding packing and sealing compounds are described in this 8-pp pocket-sized folder. Dramatizes losses sustained through unnecessary leaks, and shows how such losses may be eliminated. Describes packings as pencil- or washer-shaped pieces, which are bent or broken and pushed into stuffing-box. Gland follower is then tightened until a solid bushing is formed, and more material added if required. Surveys, Inc.

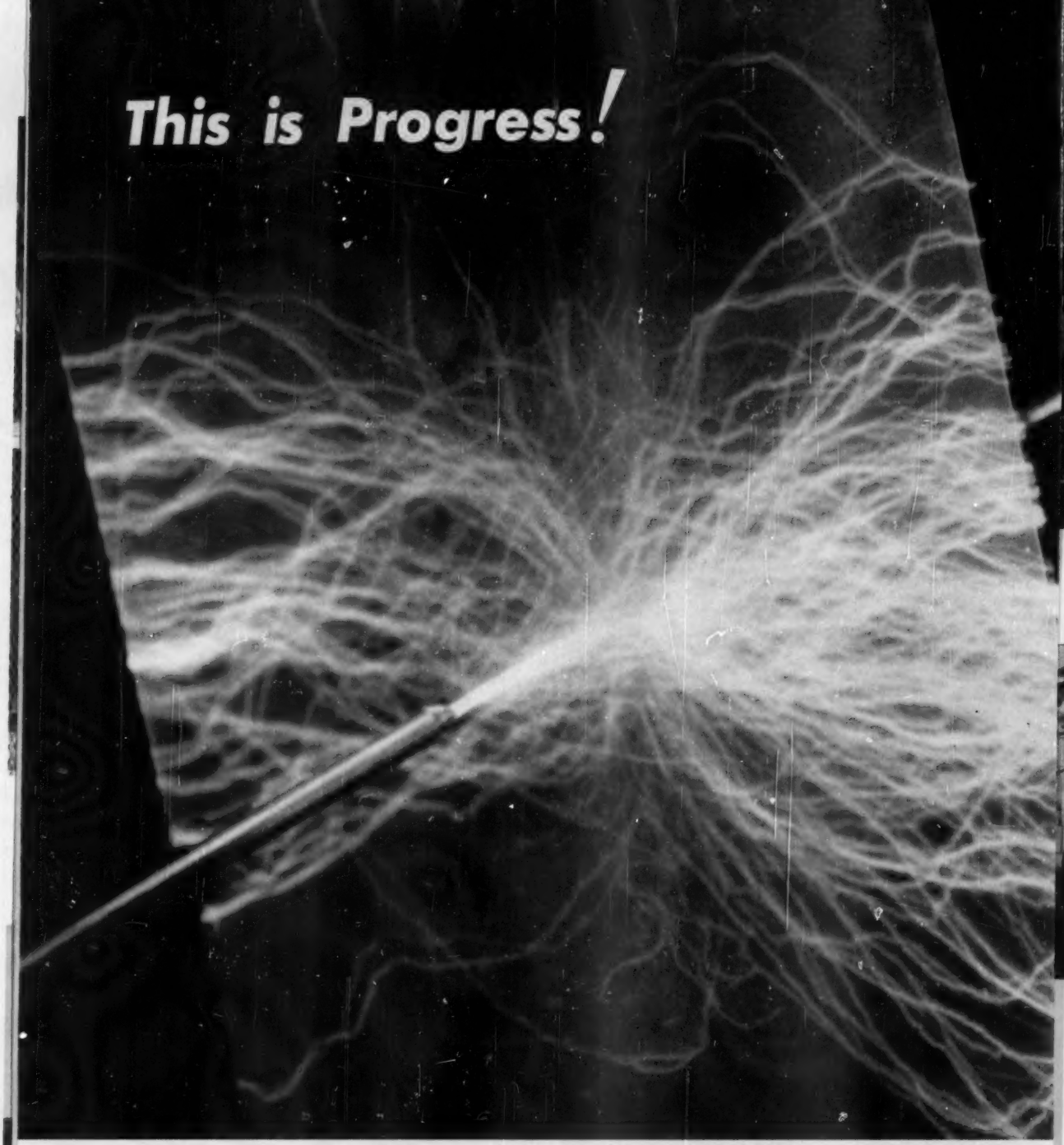
162 Synthetic Filter Cloths — To help select right filter cloth for any application in filtration or dust collection, this 6-pp folder presents engineering data and other pertinent information. Feon Dynel, Nylon, Orlon, Polyethylene, Saran, and other materials are covered. Provides charts of chemical and temperature resistance, discussion of technical considerations, magnified views of various weaves available, and performance case histories. Filtration Fabrics Div., Filtration Engineers, Inc.

163 Magnetic Separator Equipment — Illustrated 16-pp Catalog 17 describes company's line of permanent, non-electric magnetic equipment — the Magnalarm, plate magnets, magnetic humps, grate magnets, pipeline traps, micro-magnetic separators, magnetic pulleys, and others. Includes information on the installation, technical data, specifications and available sizes. Eriez Mfg. Co.

164 Technical Refrigeration — Twelve-pp Bulletin 754 covers a complete line of environmental testing and processing equipment. Provides illustrations and specifications on recently redesigned altitude, humidity, low temperature and pre-fabricated test chambers as well as specialized testing equipment. Includes helpful engineering data. Bowser, Inc.

165 Warm-Air Heaters — A line of Paraflo warm-air, oil or gas space heaters designed for commercial and industrial use is described in Bulletin 552. The 8-pp booklet illustrates design and construction features, shows application and installation information and gives engineering data on these 200,000 or 250,000 Btu per hr capacity heaters which are especially suited for industrial and commercial buildings. Dravo Corp.

166 Sectional Belt Conveyor — A complete set of belt conveyor components pre-engineered for on the job assembly is described in Bulletin 1454. Discusses chief features, lists components and gives specifications for all parts. Points out that conveyor components can be purchased from stock as a package unit for a complete belt conveyor installation, or as repair or replacement units on existing conveyors. Stephens-Adamson Mfg. Co.

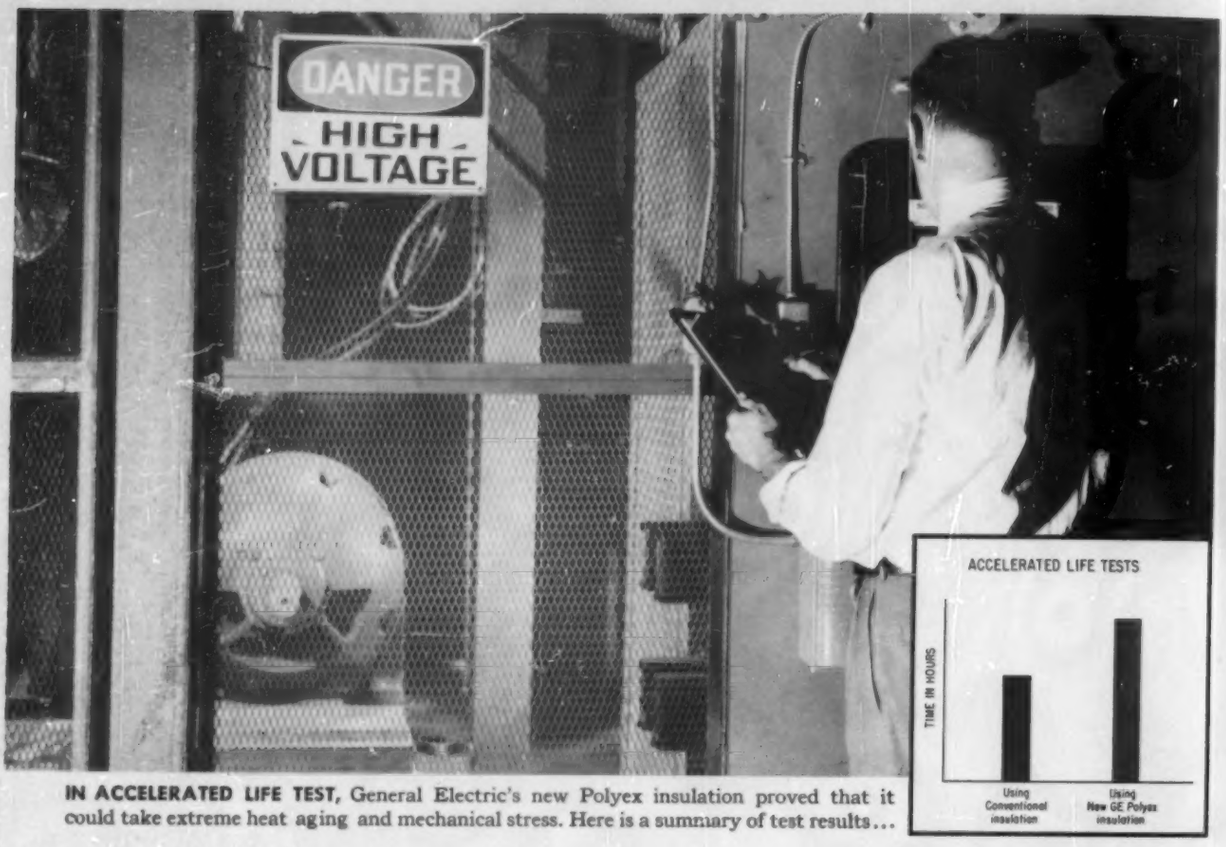


HIGH-POTENTIAL TESTS HELP PROVE . . .

NEW INSULATION MAKES G-E MOTORS LAST 50% LONGER

See Details Inside

50% LONGER MOTOR LIFE



IN ACCELERATED LIFE TEST, General Electric's new Polyex insulation proved that it could take extreme heat aging and mechanical stress. Here is a summary of test results...

7 TIMES GREATER PHYSICAL STRENGTH

TENSILE STRENGTH of new insulation offers a greater protection against physical stress.

CUT-THROUGH STRENGTH, seven times greater than conventional insulation, is another reason for long life.

An engineering ach

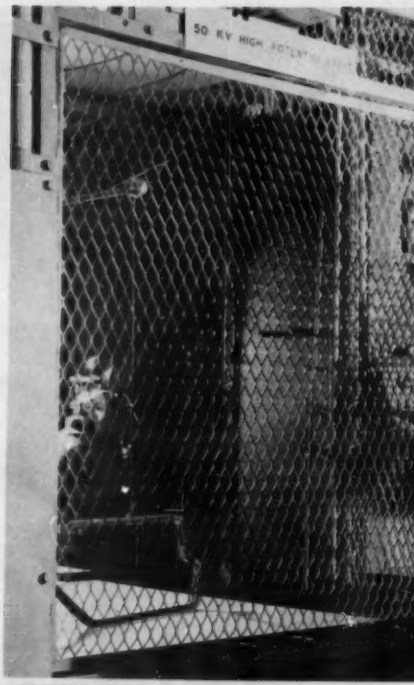
Genera
That

REVOLUTIONARY *POL*
OF THE AMAZING PROP

General Electric has developed
new Class A insulation for form-
which lasts 50% longer than other i
use today. Its greater ability to wit
ical and thermal stresses provide
margin of protection that will mean
savings to you because of reduced m
and maintenance costs.

POLYEX INSULATION is a balanc
polyester films and fibres, togethe
hydrocarbon resins. Materials in
insulation have high dielectric

50% MORE DIE



INITIAL DIELECTRIC STRENGTH TEST meas
ures insulation's ability to withstan
operating and starting voltages, and th
protection offered against insulation failure

achievement of vital importance to users of motors with form-wound coils . . .

eral Electric Develops New Insulation for Motors
t is 7 Times Tougher, Adds 50% to Motor Life

POLYEX INSULATION TAKES FULL ADVANTAGE ROPERTIES OF NEW POLYESTER FILMS AND FIBRES

ped a completely form-wound coils her insulations in o withstand phys- ovides an added mean tremendous ced motor failures

lanced system of gether with new in new Polyex ric and physical

strength. For the first time, the cotton and paper-based tapes and sheets in conventional insulations have been eliminated.

RESULTS OF EXHAUSTIVE TESTS on new Polyex insulation are summarized on these pages. Insulation qualities like these offer you tremendous savings in motor maintenance and a greater degree of service continuity than ever before possible.

GENERAL ELECTRIC RESEARCH for better insulation is a continuing program. Polyex insulation is the latest result of that program. Three years of intensive development and testing of materials and manufacturing techniques culminated in the most significant advance in large motor insulation in 45 years.

POLYEX INSULATION IS NOW AVAILABLE in many ratings of General Electric induction motors in the range of 100 to 30 at no extra cost.

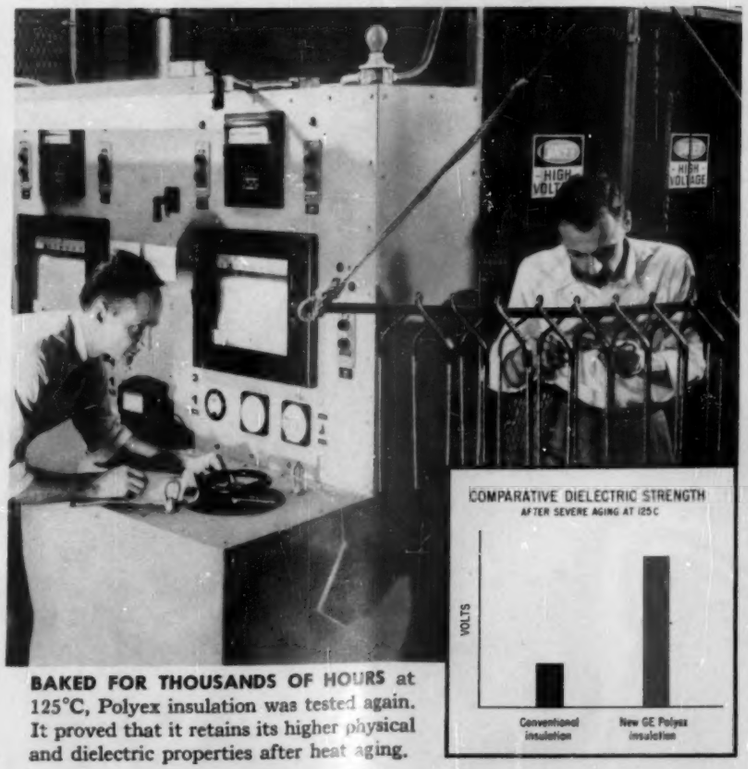
YOUR G-E SALES REPRESEN complete information. Contact nearby Genera! Electric Apparatu *General Electric Company, Sc New York.*

Progress Is Our Most Important Product

GENERAL ELECTRI

DIELECTRIC STRENGTH, EVEN AFTER HEAT AGING

meas- stand d the ailure.

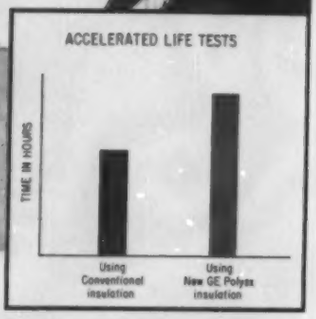


BAKED FOR THOUSANDS OF HOURS at 125°C, Polyex insulation was tested again. It proved that it retains its higher physical and dielectric properties after heat aging.

CONTAMINANT RESISTANCE DO

IN SALT SOLUTION, insulation's ability to resist contaminants was tested. Polyex-insulated coils were still operating long after conventional coils had failed.

50% LONGER MOTOR LIFE



O LIFE TEST, General Electric's new Polyex insulation proved that it ne heat aging and mechanical stress. Here is a summary of test results...

An engineering achievement of v

General Electr
That is 7 Tim

REVOLUTIONARY *POLYEX* INSULATION T
OF THE AMAZING PROPERTIES OF NEW PO

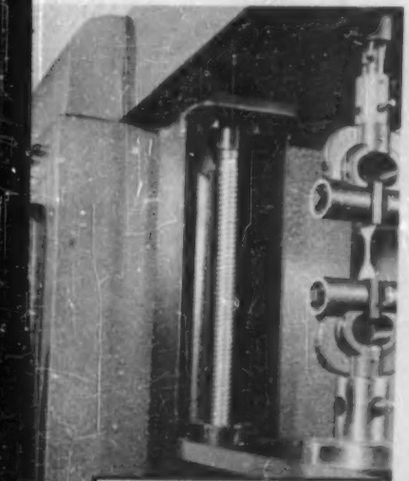
General Electric has developed a completely new Class A insulation for form-wound coils which lasts 50% longer than other insulations in use today. Its greater ability to withstand physical and thermal stresses provides an added margin of protection that will mean tremendous savings to you because of reduced motor failures and maintenance costs.

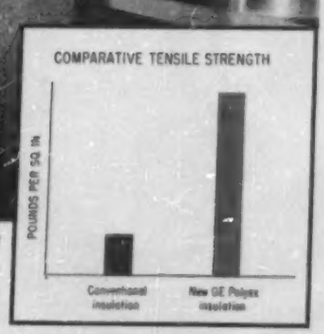
POLYEX INSULATION is a balanced system of polyester films and fibres, together with new hydrocarbon resins. Materials in new Polyex insulation have high dielectric and physical strength. B based tap tions have

RESULTS Polyex ins Insulati mendous a greater ever befor

GENERA insulation

7 TIMES GREATER PHYSICAL STRENGTH

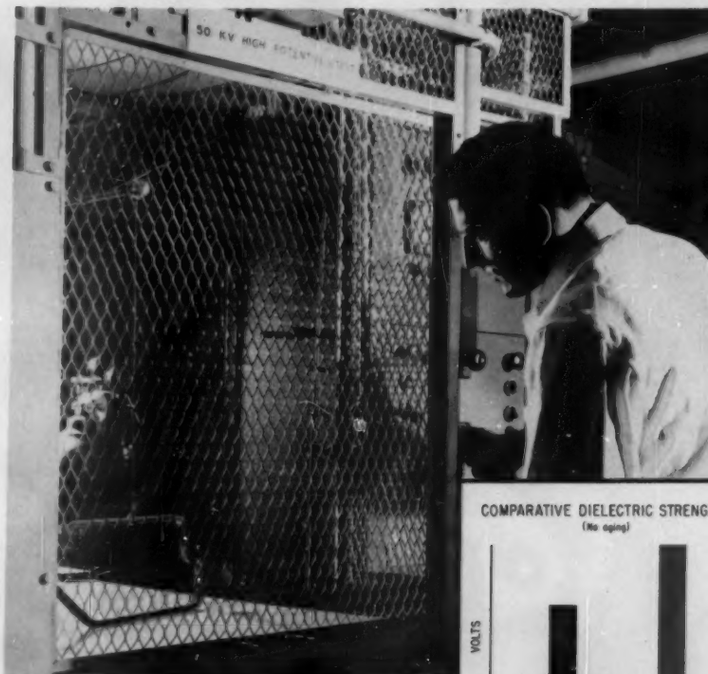




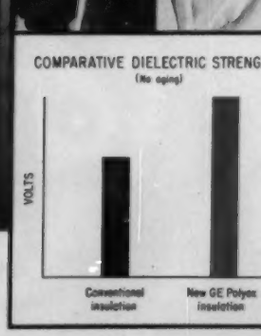
TH of
ffers
tion
ress.

CUT-THROUGH STRENGTH, seven times greater than conventional insulation, is another reason for long life.

50% MORE DIELECTRIC STREN



INITIAL DIELECTRIC STRENGTH TEST measures insulation's ability to withstand operating and starting voltages, and the protection offered against insulation failure.



f vital importance to users of motors with form-wound coils . . .

tric Develops New Insulation for Motors imes Tougher, Adds 50% to Motor Life

N TAKES FULL ADVANTAGE POLYESTER FILMS AND FIBRES

gth. For the first time, the cotton and paper- tapes and sheets in conventional insula- have been eliminated.

SULTS OF EXHAUSTIVE TESTS on new x insulation are summarized on these pages. ulation qualities like these offer you tre- ous savings in motor maintenance and ater degree of service continuity than before possible.

NERAL ELECTRIC RESEARCH for better tion is a continuing program. Polyex insulation is the latest result of that program. Three years of intensive development and testing of materials and manufacturing techniques culminated in the most significant advance in large motor insulation in 45 years.

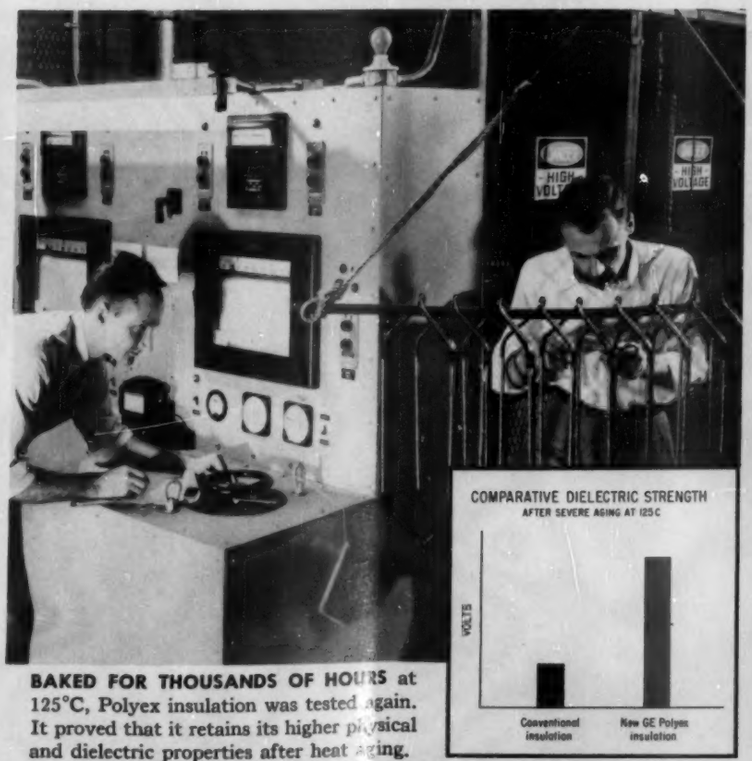
POLYEX INSULATION IS NOW AVAILABLE in many ratings of General Electric induction motors in the range of 100 to 3000 HP—and at no extra cost.

YOUR G-E SALES REPRESENTATIVE has complete information. Contact him at your nearby General Electric Apparatus Sales Office. *General Electric Company, Schenectady 5, New York.*

Progress Is Our Most Important Product

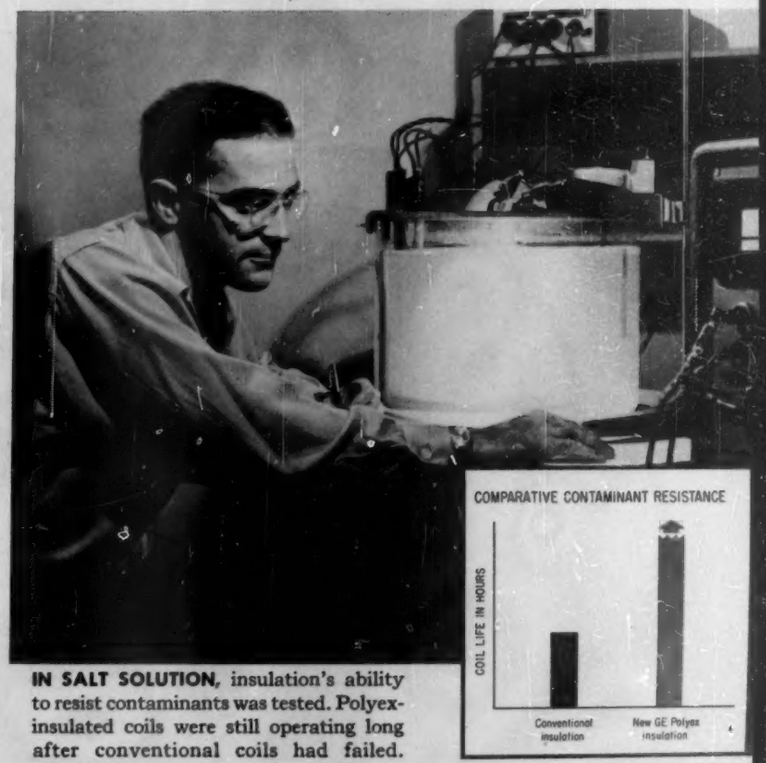
GENERAL ELECTRIC

RENGTH, EVEN AFTER HEAT AGING



BAKED FOR THOUSANDS OF HOURS at 125°C, Polyex insulation was tested again. It proved that it retains its higher physical and dielectric properties after heat aging.

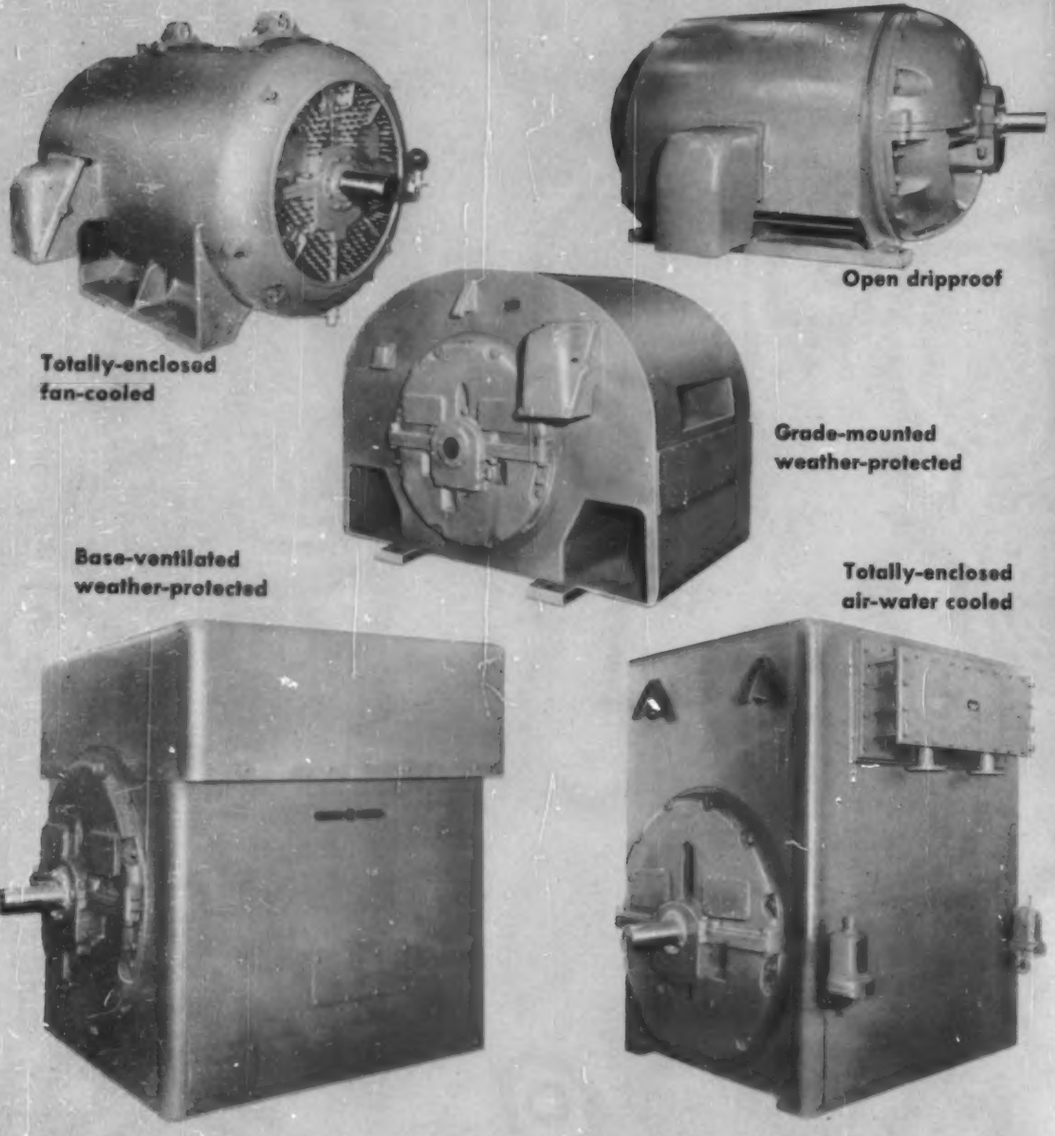
CONTAMINANT RESISTANCE DOUBLED



IN SALT SOLUTION, insulation's ability to resist contaminants was tested. Polyex-insulated coils were still operating long after conventional coils had failed.

NOW AVAILABLE IN MANY RATINGS OF THESE G-E INDUCTION MOTORS

(Approximately 100 to 3000 hp)



Totally-enclosed fan-cooled

Open dripproof

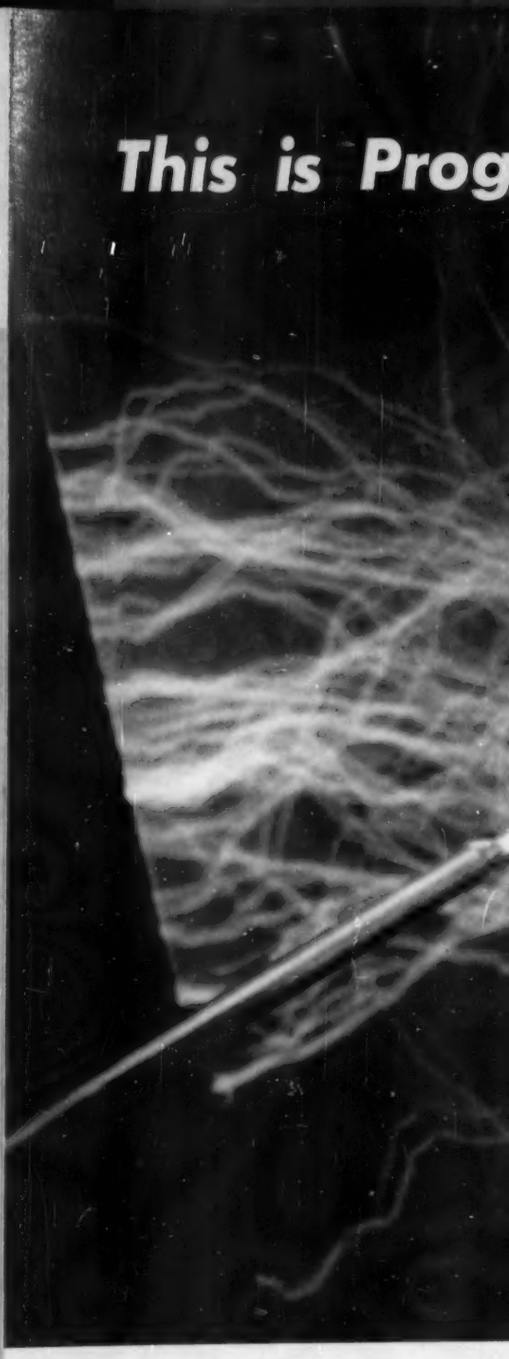
Grade-mounted weather-protected

Base-ventilated weather-protected

Totally-enclosed air-water cooled

Progress Is Our Most Important Product

GENERAL ELECTRIC

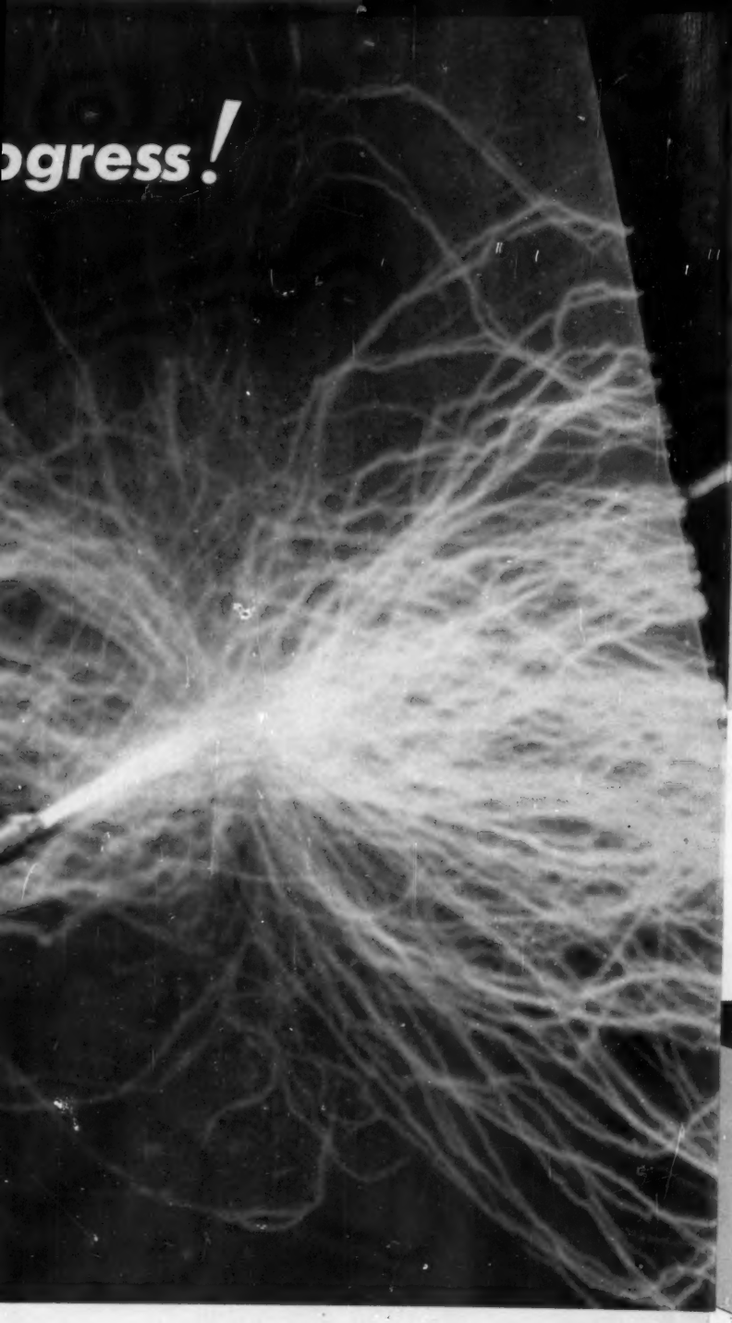


This is Prog

HIGH-POTENTIAL TESTS

NEW INSULA MOTORS LA

See Details Inside

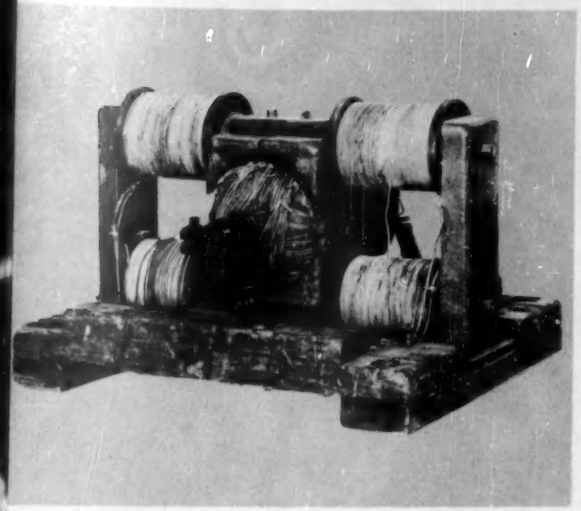


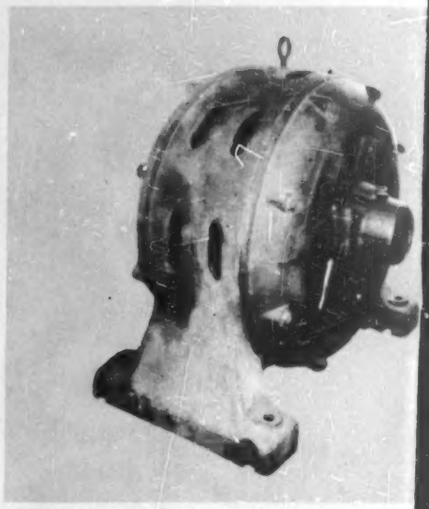
ogress!

STS HELP PROVE...

LATION MAKES G-E
AST 50% LONGER

THE THIRD MAJOR STEP IN THE EVOLUTION
FORM-WOUND MOTOR INSULATION SYSTEM





1878—FORM 1 INSULATION SYSTEM

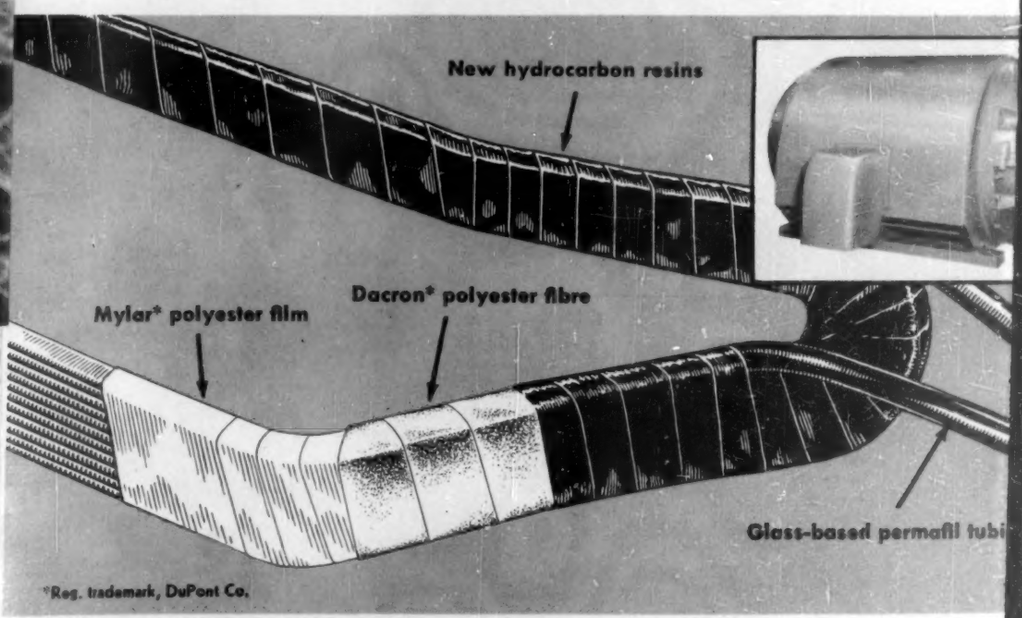
Air was the insulator in early motor coils. Cotton was wrapped around the coils, but served only as a spacer to provide an air gap. The cotton wrapping itself was worthless as an insulator.

1910—FORM 2 INSULATION SYSTEMS EST

Linseed oil was added to cotton to provide qualities. Since then, varnish and other materials have replaced oil, but until now concept has remained the same.

1954—G.E. INTRODUCES FIRST FORM 3 INSULATION SYSTEM

New G-E Polyex insulation becomes the first Form 3 insulation system. Made of polyester films and fibre is the first insulation in which the materials have natural insulating qualities of their own.



*Reg. trademark, DuPont Co.

Progress Is Our Most Important Product

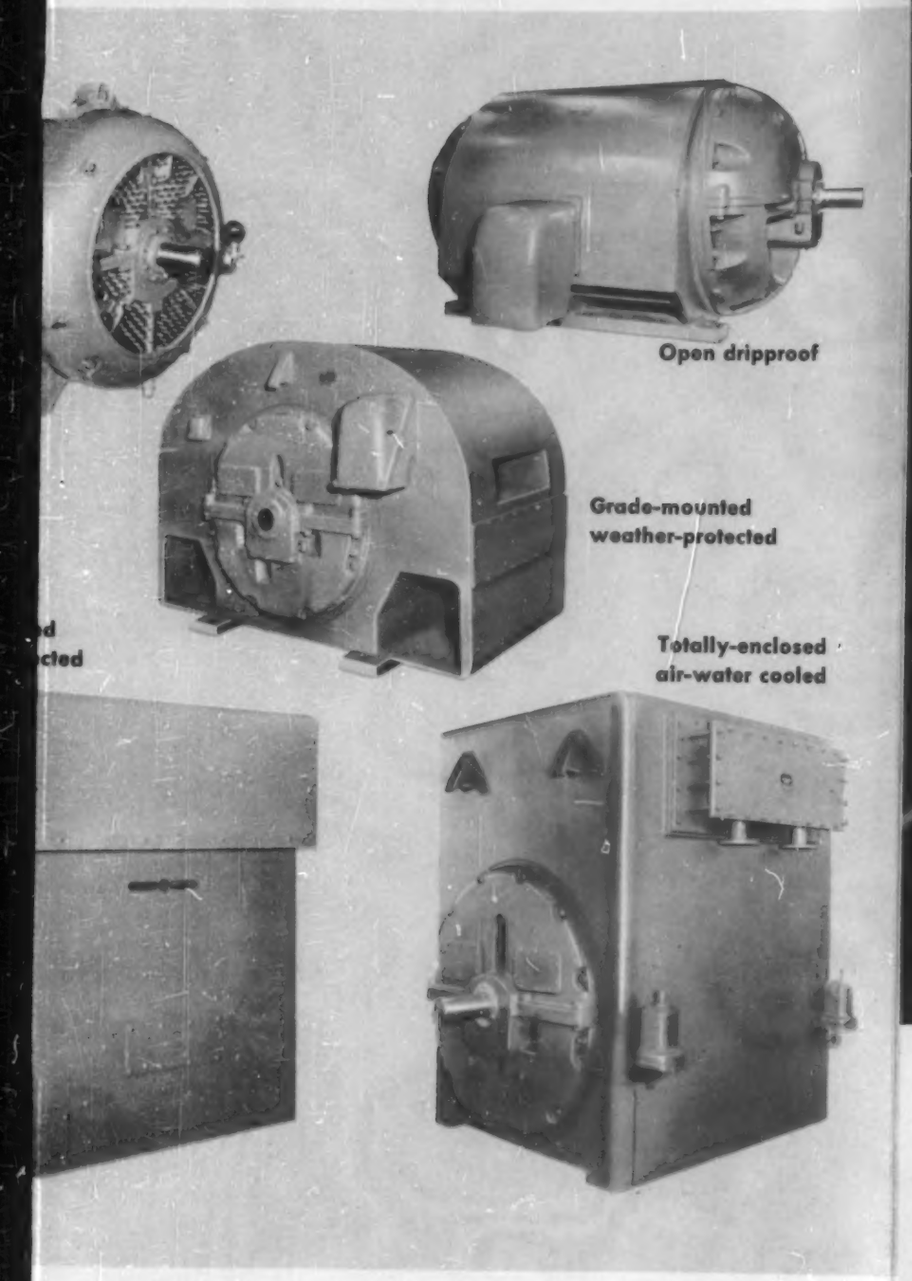
GENERAL ELECTRIC

830-14

Want to kee
informatio
Tear along perfor

AVAILABLE IN MANY RATINGS
ESE G-E INDUCTION MOTORS

(Approximately 100 to 3000 hp)



Open dripproof

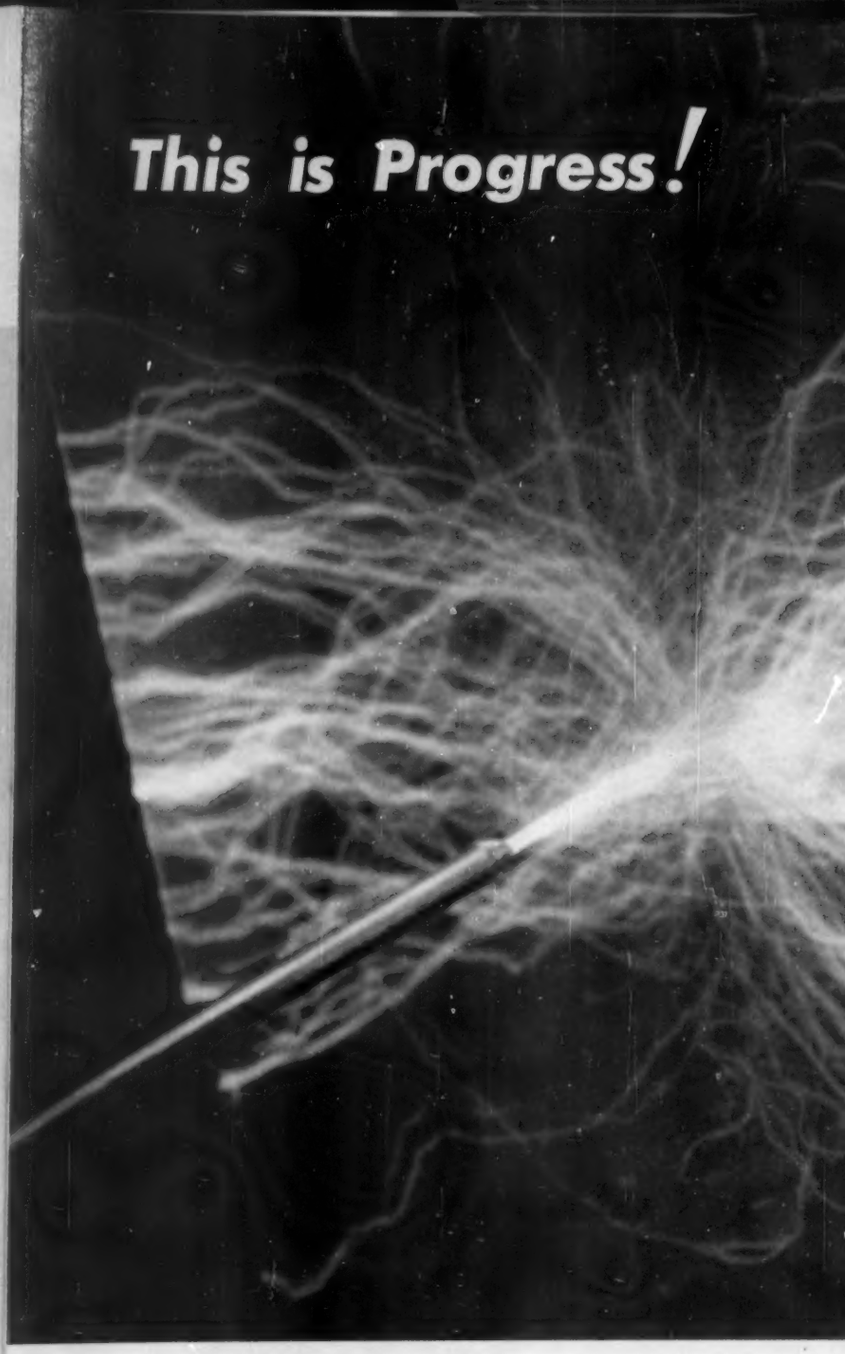
Grade-mounted
weather-protected

d
cted

Totally-enclosed
air-water cooled

Progress Is Our Most Important Product

NERAL ELECTRIC

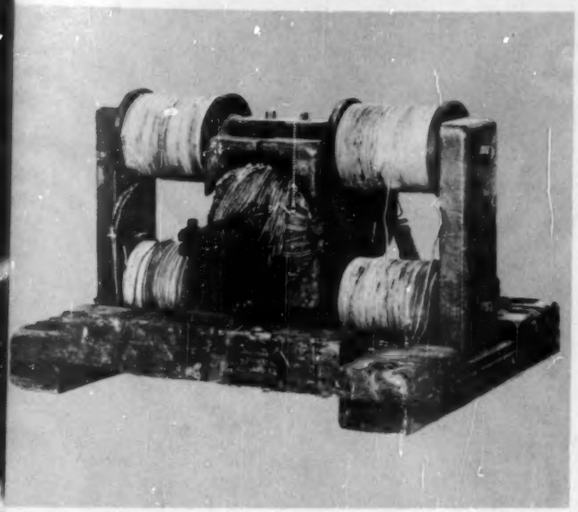


HIGH-POTENTIAL TESTS HELP PROVE . . .

NEW INSULATION MA
MOTORS LAST 50%

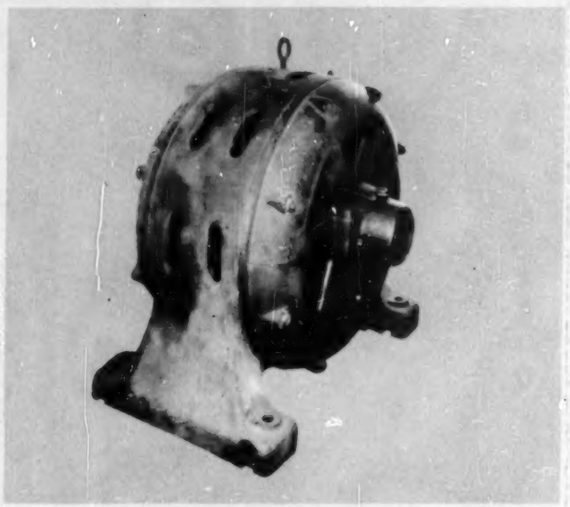
See Details Inside

THE THIRD MAJOR STEP IN THE EVOLUTION OF FORM-WOUND MOTOR INSULATION SYSTEMS



1878—FORM 1 INSULATION SYSTEM

Air was the insulator in early motor coils. Cotton was wrapped around the coils, but served only as a spacer to provide an air gap. The cotton wrapping itself was worthless as an insulator.

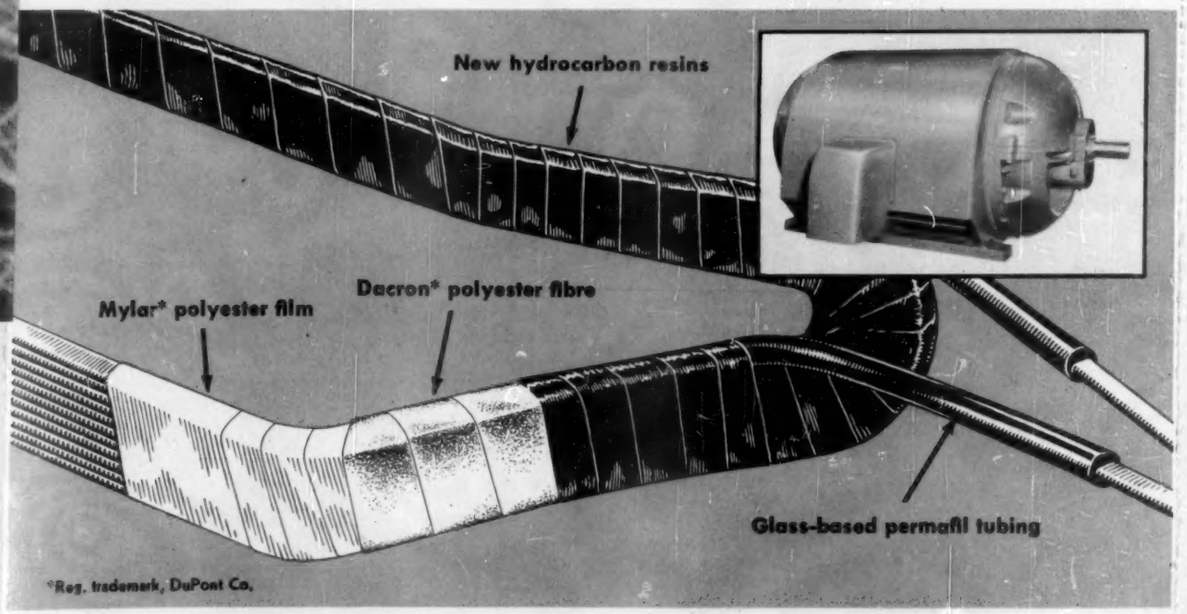


1910—FORM 2 INSULATION SYSTEMS ESTABLISHED

Linseed oil was added to cotton to provide insulating qualities. Since then, varnish and other insulating materials have replaced oil, but until now the basic concept has remained the same.

1954—G.E. INTRODUCES FIRST FORM 3 INSULATION SYSTEM

New G-E Polyex insulation becomes the first Form 3 insulation system. Made of polyester films and fibres, Polyex is the first insulation in which the materials have natural insulating qualities of their own.



...AKES G-E LONGER

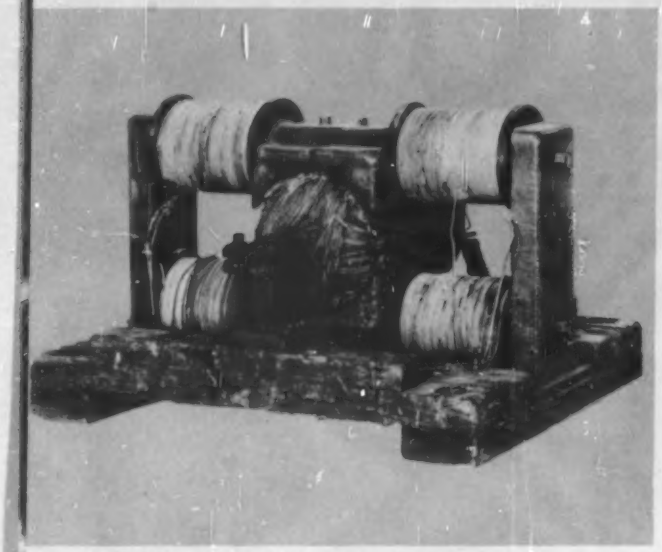
Progress Is Our Most Important Product

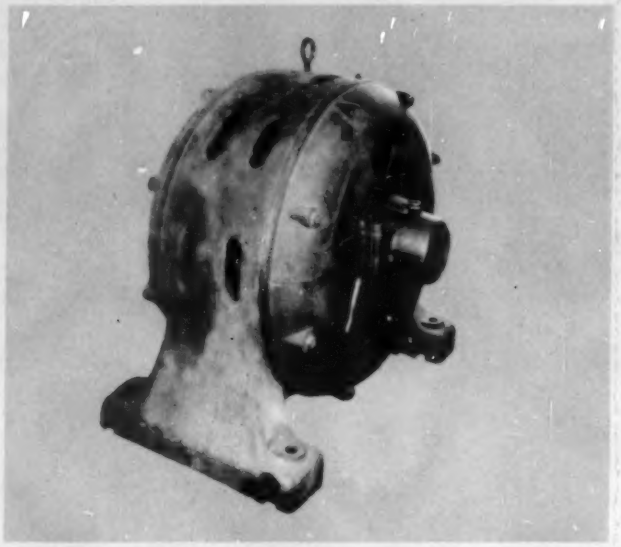
GENERAL ELECTRIC

830-14

Want to keep this information? Tear along perforated edge.

THE THIRD MAJOR STEP IN THE EVOLUTION OF FORM-WOUND MOTOR INSULATION SYSTEMS





1878—FORM 1 INSULATION SYSTEM

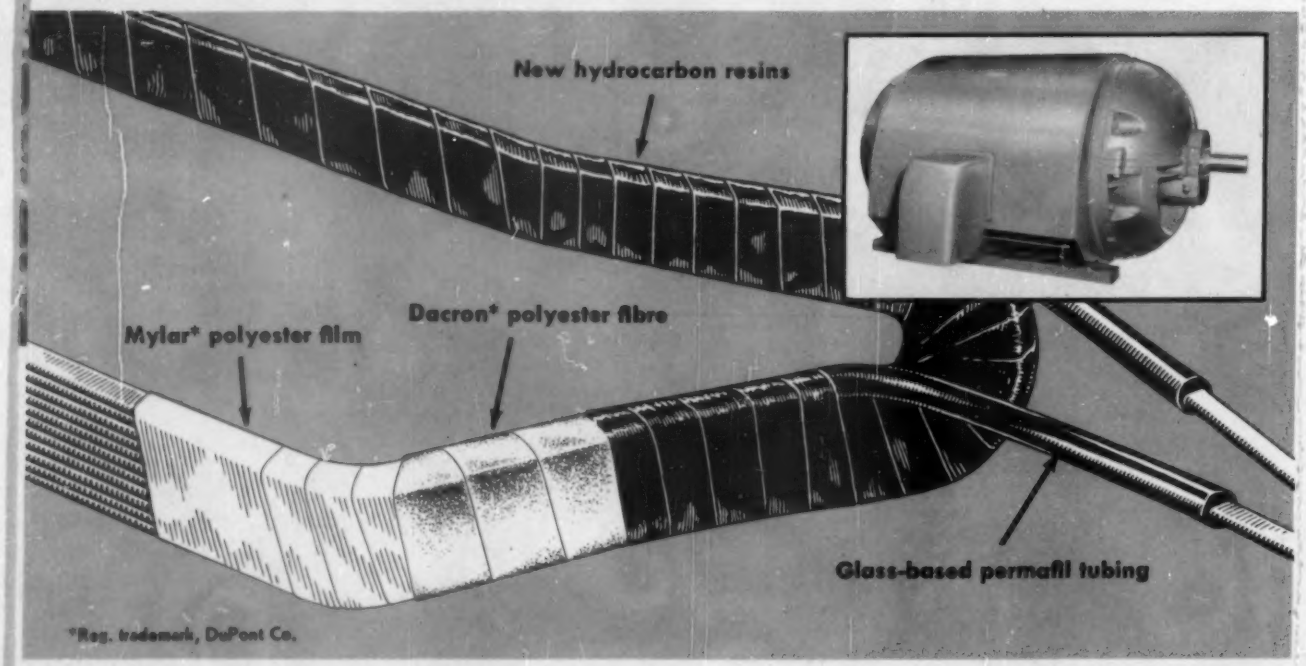
Air was the insulator in early motor coils. Cotton was wrapped around the coils, but served only as a spacer to provide an air gap. The cotton wrapping itself was worthless as an insulator.

1910—FORM 2 INSULATION SYSTEMS ESTABLISHED

Linseed oil was added to cotton to provide insulating qualities. Since then, varnish and other insulating materials have replaced oil, but until now the basic concept has remained the same.

1954—G.E. INTRODUCES FIRST FORM 3 INSULATION SYSTEM

New G-E Polyex insulation becomes the first Form 3 insulation system. Made of polyester films and fibres, Polyex is the first insulation in which the materials have natural insulating qualities of their own.



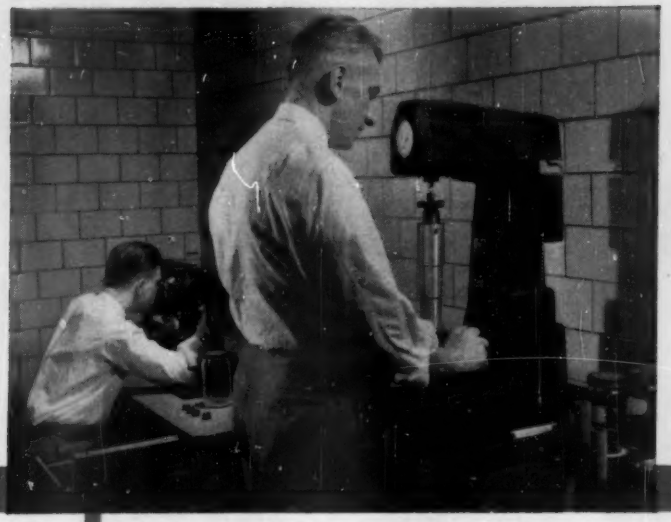
Progress Is Our Most Important Product

GENERAL ELECTRIC

830-14

Want to keep this information? Tear along perforated edge.

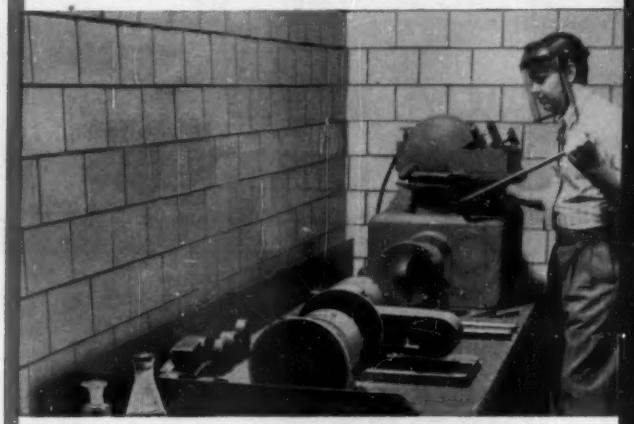
◀ Heat-treating and physical testing equipment shown at left is used for quality control of welding operators and for development of new welding procedures.



▲ This Rockwell hardness testing machine measures the hardness of weld specimens as a guide to proper procedures for heat-treating of welds.

Daily rigid testing is your insurance of quality welds in

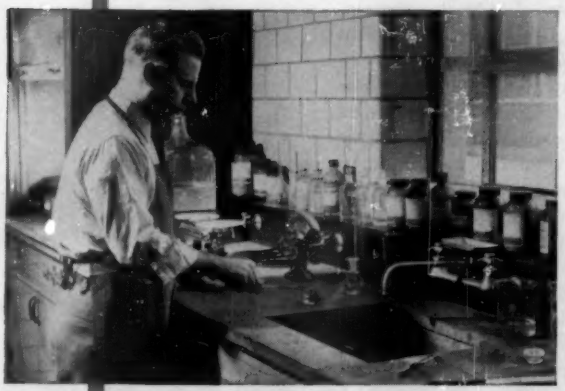
NAVCO FABRICATED PIPING



▲ A laboratory technician cuts a sample from a pipe weld prior to grinding and polishing for metallographic examination.

At Navco, a continuous parade of weld specimens are processed in the new, modern physical-chemical testing laboratory. It is here that weldments are studied metallographically and tested physically—all on a rigid schedule of quality control practices. Navco customers have benefited from progressive quality control practices for more than 40 years; they have come to know that piping installations, engineered, fabricated and erected by Navco, are precise, accurate and dependable.

Call on NAVCO for your next piping job.



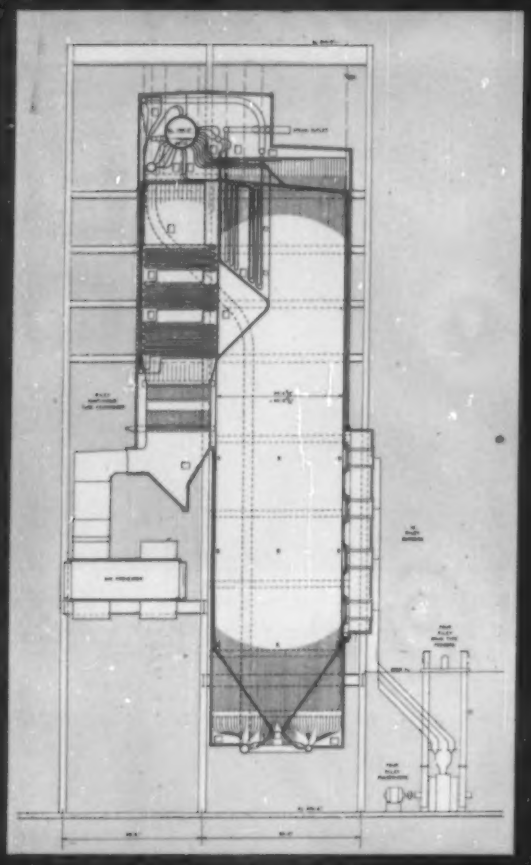
▲ Here a weld specimen is etched to outline the grain structure for further metallographic study.

NATIONAL VALVE & MANUFACTURING COMPANY

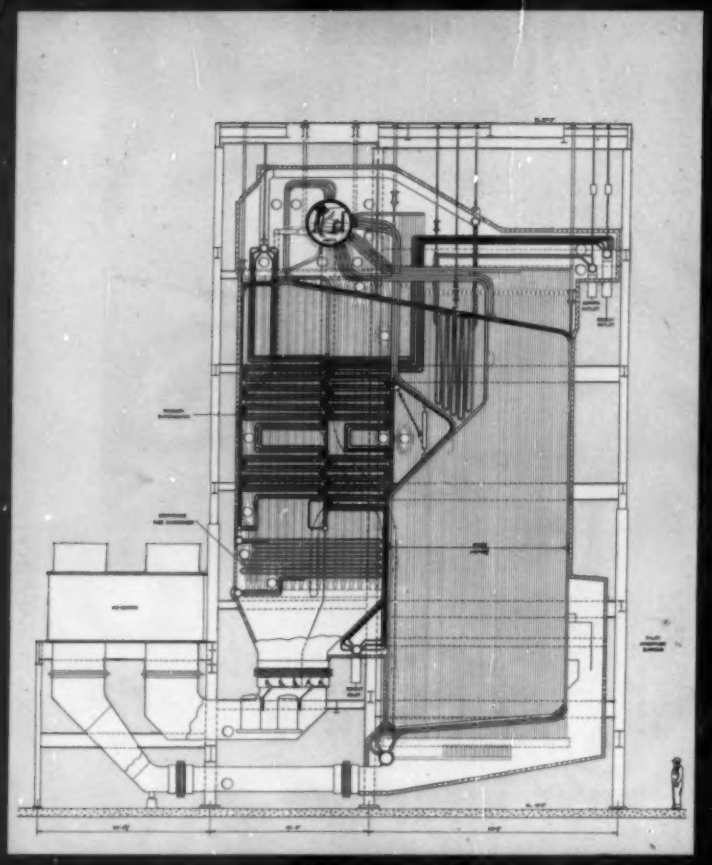
3107 LIBERTY AVENUE, PITTSBURGH 1, PENNSYLVANIA

New York • Chicago • Cleveland • Boston • Atlanta • Buffalo • Cincinnati

For more data circle 524 on Post Card



For Picway Steam Station
Columbus & Southern Ohio Electric Co.
900,000 lbs/hr; 1500 psig; 950 F; Eff. 86.5%

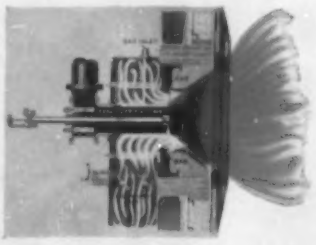


For Teche Power Station
Central Louisiana Electric Company
350,000 lbs/hr; 1650 psig; 1005F/1005F Reheat; Eff. 84.8%

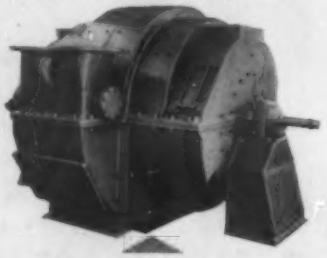
FUEL: OHIO STRIP MINE COAL

This unit was designed to operate under peaking load conditions with Ohio Strip Mine Coal having a moisture content of 16% and containing 10% ash, with Btu of 10,500 and fusion temperature of 2100 F. These coal specifications warranted a furnace with a heat release of 13,500 Btu per cu. ft. of volume, and 85,000 Btu per sq. ft. of projected envelope. The unit is fired by 16 Riley Flare Type Burners and four 15 ton-per-hour Riley #550 Duplex Pulverizers. Erosion resistant tungsten carbide faced pulverizing parts in the mills assure sustained high fineness and low maintenance cost over months of continuous operation. Commonwealth Associates, Engineers

Riley Flare Type Burner



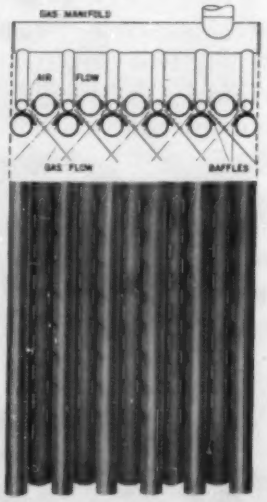
Riley #550 Duplex Pulverizer



FUEL: NATURAL GAS

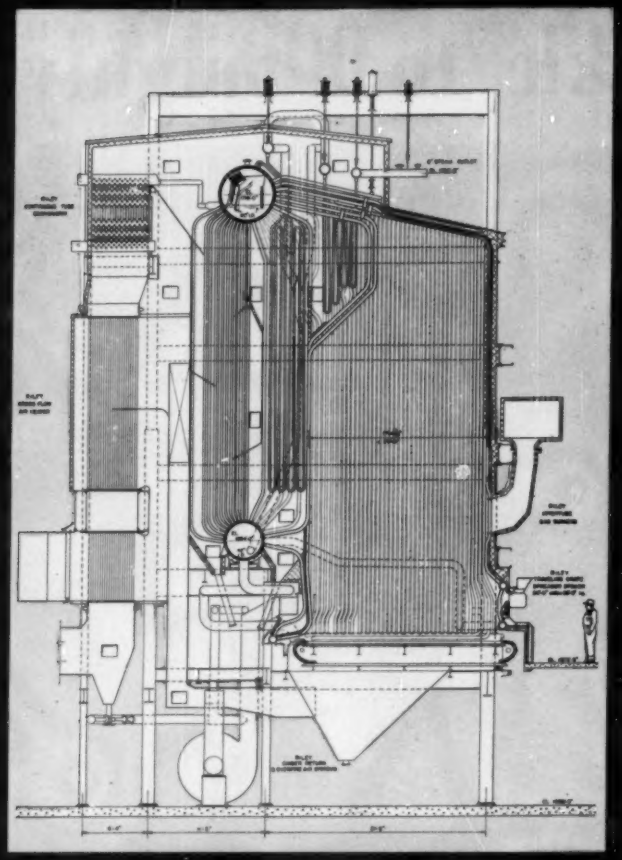
This relatively small compact Riley pressurized unit will provide the economy of reheat to power a turbine with a nominal rating of 50,000 kw. New Riley Intertube Gas Burners for firing natural gas make possible low excess air, and eliminate exposed burner refractory. "Wall of Flame" characteristic of this new Riley burner provides unusual uniformity of heat distribution across furnace with uniform heat absorption across superheater. Superheat and reheat temperatures are maintained by a combination of spray for superheat and damper control for reheat. Sargent & Lundy, Engineers.

Riley Intertube Burner



RILEY INTERTUBE GAS BURNERS
Notice absence of refractory. Front row of tubes are part of waterwall, and provides water-cooled protection to gas burners.

COMPLETE STEAM GENERATING UNITS AND FUEL BURNING EQUIPMENT



For R. M. Heskett Station
Montana-Dakota Utilities
250,000 lbs/hr; 1025 psig, 905F; Eff. 79.0%

RILEY steam generating units

. . . selected for high yearly net efficiency, continuity of operation and dependability . . . three of the many Riley units recently purchased by leading public utility companies: In the past few years there has been a decided swing to Riley because of satisfactory performance of hundreds of existing Riley units.

Here are a few other recent Riley sales to Public Utility Companies—

Louisiana Power & Light Co.	1-1,000,000 lbs/hr Reheat
New Orleans Public Service, Inc.	1-975,000 lbs/hr S.G.U.
Houston Lighting & Power Co.	2-1,250,000 lbs/hr Reheat
Texas Electric Service Co.	1-1,250,000 lbs/hr Reheat
City of Los Angeles	2-1,200,000 lbs/hr Reheat
Dallas Power & Light Co.	1-1,050,000 lbs/hr S.G.U.
Monongahela Power Co.— The Potomac Edison Co.	2-700,000 lbs/hr S.G.U.
Southwestern Gas & Electric Co.	1-630,000 lbs/hr S.G.U.
Taiwan Power Co., Taiwan	1-425,000 lbs/hr RX Unit
Florida Power Corporation	1-600,000 lbs/hr Reheat
Southern Nevada Power Co.	1-425,000 lbs/hr S.G.U.
Commonwealth Edison Co.	1-450,000 lbs/hr S.G.U.
Public Service Co. of Indiana, Inc.	1-805,000 lbs/hr Reheat
Iowa Electric Light & Power Co.	2-300,000 lbs/hr S.G.U.

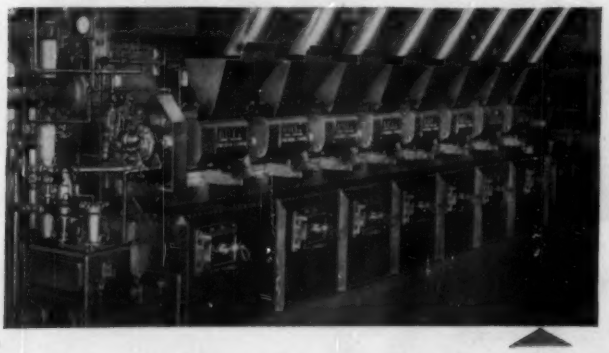
A survey of your power plant will possibly show ways of making surprisingly large savings in your power costs.

FUEL: LIGNITE AND NATURAL GAS

This combination of a Riley Traveling Grate Spreader Stoker for burning lignite, and Riley Intertube Burners for natural gas, assures maximum performance whether fuels are burned singly or in combination.

Each method of firing provides even distribution of heat in furnace. There is no exposed refractory in the Riley Intertube Burners and they receive water-cooled protection when firing lignite. Specified steam temperature is maintained regardless of fuel used by Riley heat exchanger in lower drum. Unit also features a Riley single-pass, two-section Air Heater and a Riley Continuous Tube Economizer. Ebasco Services, Engineers.

Riley Traveling Grate Spreader Stoker



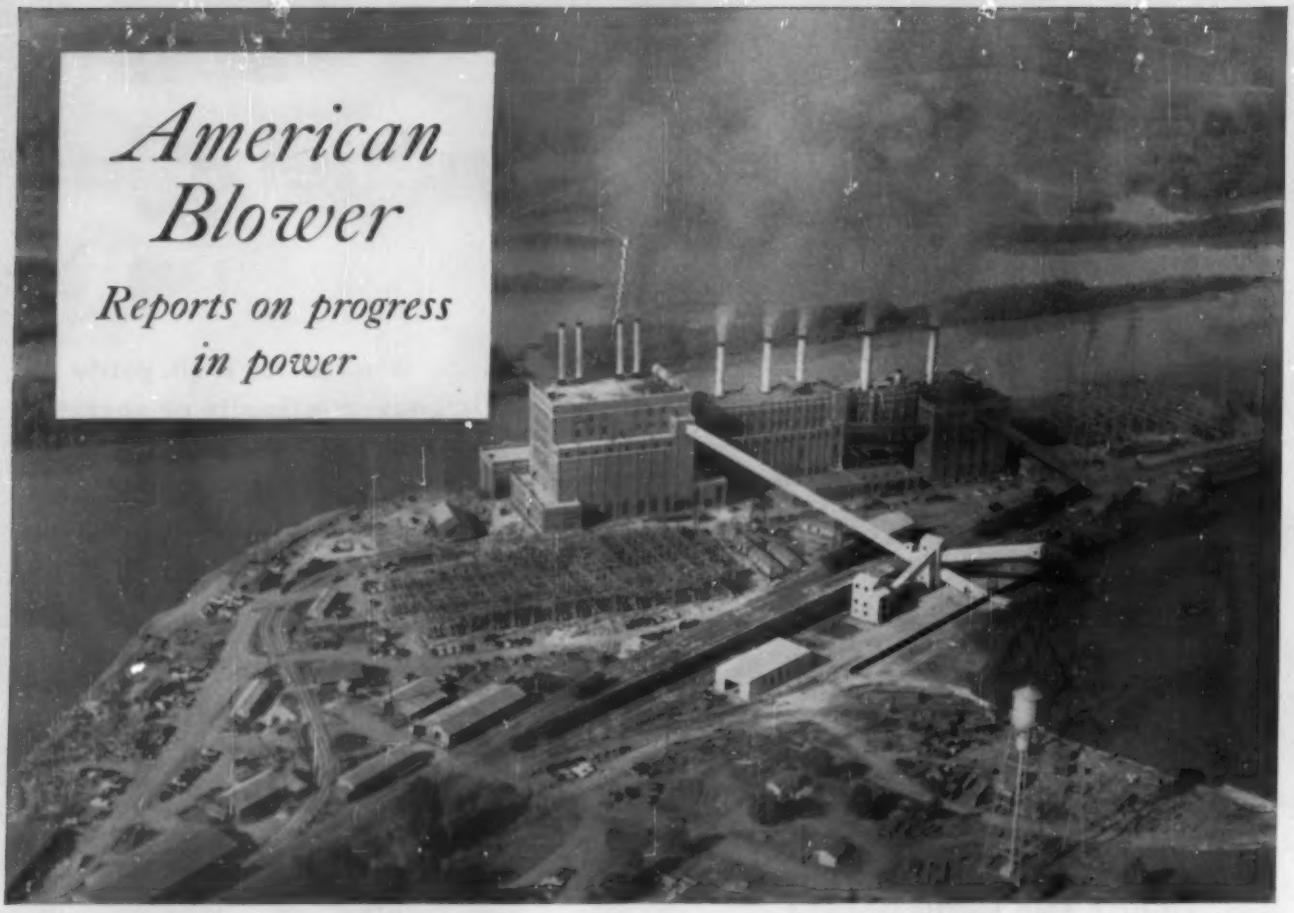
RILEY
Stoker Corporation
WORCESTER, MASSACHUSETTS

Boston, New York, Philadelphia, Buffalo, Washington, Pittsburgh, Cleveland, Detroit, Chicago, Cincinnati, Charlotte, New Orleans, Atlanta, St. Louis, Kansas City, St. Paul, Tulsa, Houston, Denver, Salt Lake City, Los Angeles, San Francisco, Portland, Seattle.

FOR PUBLIC UTILITIES AND INDUSTRIAL POWER AND HEATING PLANTS

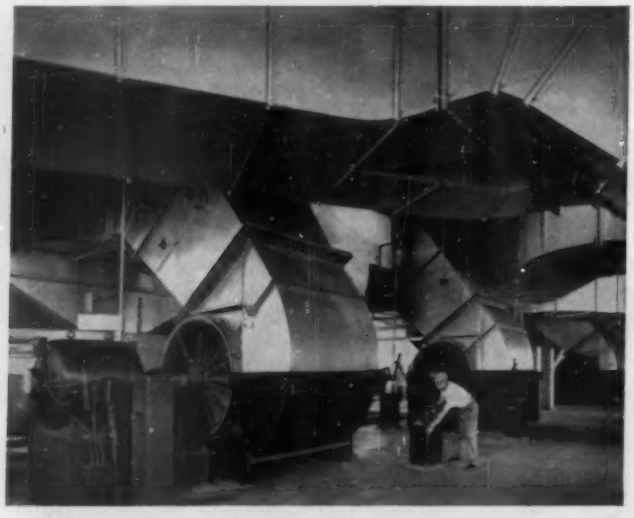
For more [illegible] circle 526 on Post Card

From a tiny trickle to a mighty



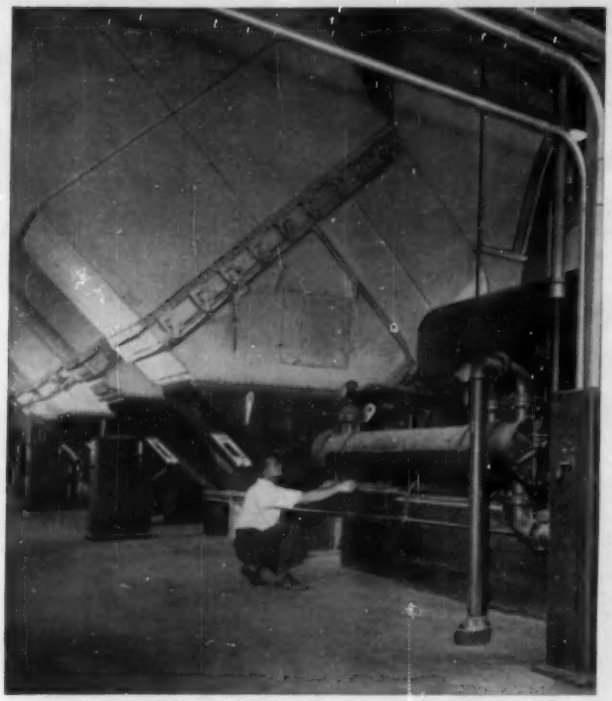
1. Duke Power's Buck Plant (above) near Salisbury, N.C., increased capacity by 250,000 kw in 1953. Two new generating units, recently completed, also added 266,000 kw to the Riverbend Plant near Charlotte, N.C. At the Dan River Plant near Draper, N.C., a new 150,000 kw unit is under construction, to be completed in 1955. Two other Duke Power plants are: Cliffside near Shelby, N.C. and Lee near Greenville, S.C.

2. American Blower Gyrol Fluid Drive – type VS, class 6 – provides smooth, adjustable speed control of a boiler feed pump. It is coupled with a 1750 hp motor in the Buck Plant.

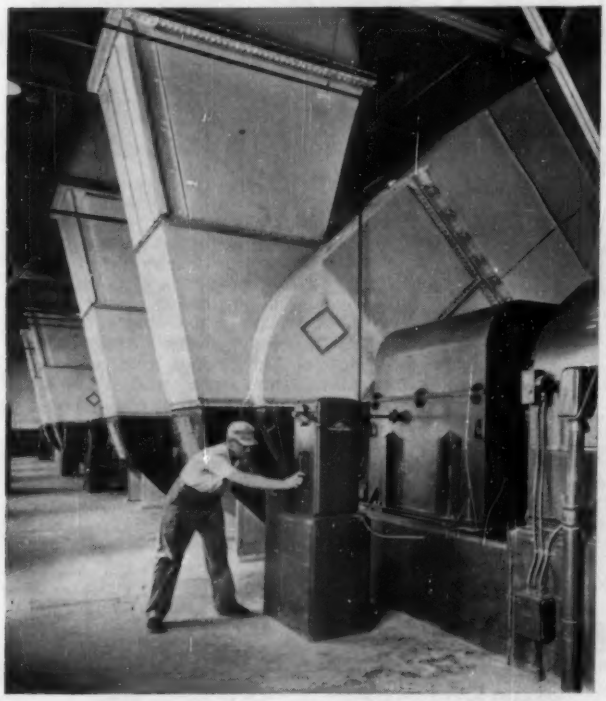


3. Four American Blower Forced Draft Fans are installed in Duke Power's Riverbend Plant. Each has a capacity of 143,000 cfm @ 100°F @ 1180 rpm @ 406 bhp.

2,211,000 kw—that's Duke Power!



4. Duke Power installed these four American Blower Induced Draft Fans at the Buck Plant. Each is driven through a type VS, class 4 American Blower Gyrol Fluid Drive.



5. Rated @ 234,000 cfm @ 296°F @ 637 bhp, each of these four American Blower Induced Draft Fans at the Riverbend Plant is coupled with an American Blower Gyrol Fluid Drive.

In its tremendous expansion, another leading power company chooses American Blower equipment

On April 1, 1904, a power line from a small hydroelectric plant at India Hook Shoals, S.C., was completed to Rock Hill, S.C. This was the simple beginning of the Duke Power Company system . . . a system that today serves over half a million customers in a 20,000-square-mile area in the Piedmont Carolinas — supplying electricity for some 35% of the nation's textile spindles . . . a system that through continued expansion will have an estimated capacity of 2,211,000 kw in 1955!

Planning far ahead of customers' needs is basic to this progressive, investor-owned utility. During the eight years from 1946 through 1953, Duke Power spent $231,000,000 to expand facilities, including $6,000,000 for the South's first steel-tower 230 kw line. Present plans call for additional expenditures, through 1964, of $30,000,000 annually. Duke Power is surging ahead with a dramatic fifty years of generating electricity behind them!

Supplying dependable air handling equipment and Gyrol Fluid Drives is the important part American Blower plays in Duke Power's tremendous expansion. (See pictures and captions.) It's a big role, one that is being duplicated in leading power and industrial plants everywhere.

If *your* future calls for expansion or modernization, talk over your plans and problems with an experienced American Blower representative. He can recommend efficient, economical equipment—including Mechanical Draft Fans, Fly Ash Precipitators, Dust Collectors, Heavy Duty Steam Coils and Gyrol Fluid Drives for boiler feed pump and fan control. Call your nearest American Blower Branch Office.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry:

AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

For more data circle 525 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 103–104 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—CONTROL UNIT signals end of ion exchange run

This electronic control, the Enditrol, is designed to indicate the end of the operating run of a hydrogen cation exchanger (hydrogen zeolite) unit. It is based on the theory that as the downflow hydrogen ion exchanger approaches exhaustion, the hydrogen concentration of the effluent has a higher conductivity than that of the upstream sample. End-points of ion exchange run can be determined by comparing conductivities of upstream sample and effluent. With proper electrical controls, device can also be used for initiating operation of existing automatic regeneration equipment. Operation of such units could be entirely automatic, it is explained, and would eliminate dangers of over-running and chemical and water waste caused by under-running. It may also be equipped with a relay which signals end of a run by an alarm or light.

In operation, a continuous flow of water is drawn from the upstream tap and comparison of this tap water with effluent results in a ratio that is constant until the resins approach exhaustion. The decrease in acidity moves downward during the run and when it reaches the tap, the ratio suddenly changes. This signals the end of the run. The control is equally applicable to anion exchangers used for silica removal where the anions are taken up by the ion exchange bed. The Permutit Co.

2—TWO-WIRE THERMOCOUPLE has stainless steel tubing

A two-wire thermocouple, encased in stainless steel tubing, is available with either of two types of terminal heads: an open head assembly or a screw-cover head. The latter comes in two sizes. The stainless steel protecting tube is reported to double the life of the thermocouples. Accuracy is rated at ±5 F, from 0 to 1000 F. Fiber glass insulation is used. Minneapolis-Honeywell Regulator Co.

3—THREAD LUBRICANT for titanium, stainless steel

This thread lubricant is announced for use on titanium, stainless steel and aluminum. It is available in two grades. Blue Goop, for temperatures to 400 F, is said to eliminate galling so threads can be reused over and over again. Silver Goop for temperatures to 2100 F is described as an effective antiseize compound for use on threaded parts of stainless steel and high temperature alloys. Crawford Fitting Co.

4—FEEDWATER CONTROLS; one, two, and three element

In these feedwater control systems, the electronic operation of the controller provides great speed of transmission and high accuracy of control, says company, and is independent of effects due to normal variations in voltage and frequency. Three systems are offered to meet requirements of large, medium or small boilers under normal or severe operating conditions. Present instruments can be utilized and pressures to 2500 psig accommodated. Other features announced include positive valve drive; operative even on cold boilers; mercury-less measuring and transmission for flow and level; direct level measurement; and independent adjustments for effects of steam flow, water flow and water level. Publication 54-1073-221 gives further details. The Hays Corp.

5—AUTOMATIC STAPLER for cable and copper tubing

Described as light in weight and packing the power of a hydraulic tool, this one-hand operated stapler speeds up the installation of electric cable lines, copper tubing. The gun is designed to shoot a heavy staple with each squeeze of the trigger — fastening the cables or tubes to many types of building materials. It is claimed that with this tool, a man can draw these lines in about ⅓ the usual time. The stapler loads heavy wire staples in many leg lengths up to ¾-in. long. Its automatic chamber feeds these large staples one at a time into a driving hammer. Staples are set around the wire to pre-determined depth to avoid fracture of material. The Heller Co.

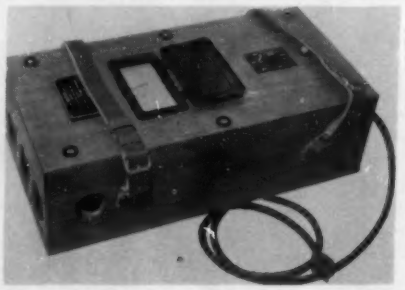
6—CIRCUIT BREAKER is compact and economical

The new "KL" is a 400-amp-frame molded case circuit breaker designed to save cost and space for users who have previously used larger, more expensive 600-amp-frame breakers in circuits carrying from 225 to 400 amp. Compact in design, the unit measures 9 in. wide, 15⅝ in. high and 5½ in. deep, including handle. It is suggested for use in panelboards, switchboards, motor controls, bus duct plugs and individual enclosures. The thermal-magnetic unit has a quick-make, quick-break operating mechanism. Interchangeable trip units provide continuous ratings from 125 to 400 amp. Common trip operation is retained, it is explained, and an overcurrent on any pole kicks out all poles simultaneously.

Extra auxiliary devices — shunt trips, undervoltage trips, auxiliary and alarm switches — can be mounted inside the breaker case. The model is available in ratings from 125 to 400 amp; either two or three-pole; 600 v a-c or 250 v d-c, 25,000 amp maximum interrupting capacity. I-T-E Circuit Breaker Co.

7—INSULATION TESTERS in triple, single voltage models

Two new models of Megger Insulation Testers are now available in rectifier-operated units. One has a range up to 100,000 megohms at 5000 v d-c with 1000 v and 2500-v intermediate ranges; the other, a range up to 200,000 megohms at 10,000 v with no intermediate voltage

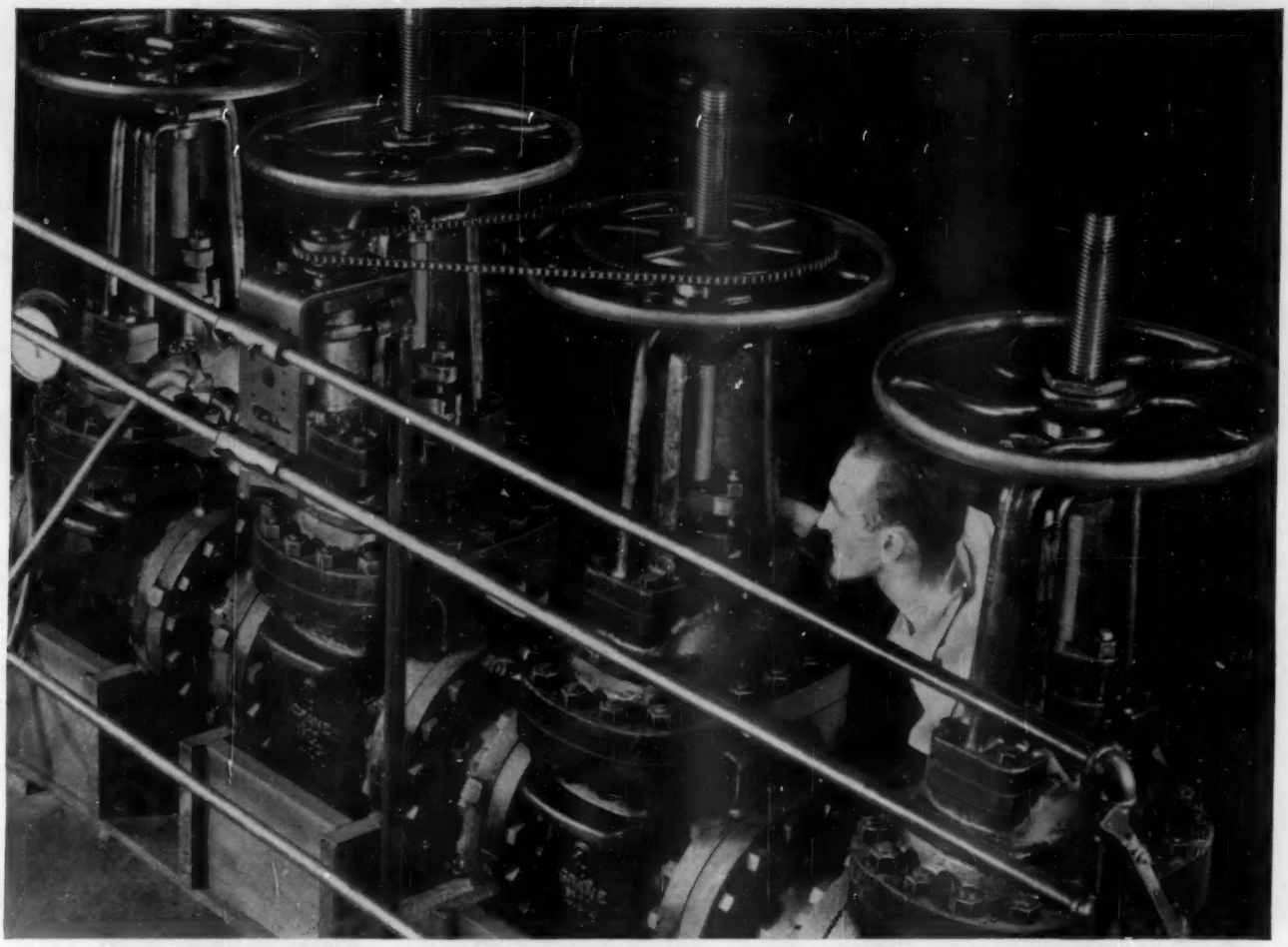


ranges. These high ranges are useful in field tests on bushing, generators, transformers and cables.

In the case of bushings, the insulation resistance of new units should be in the order of 50,000 megohms, it is pointed out, and any deterioration occurring in service, which can be detected at 2500 v d-c, will be observed with a Megger Instrument of that range and voltage. Generators, transformers and cables can have relatively high 1-min insulation resistance values which may increase with time during a time-resistance test. In such cases, manufacturer says the instrument range should be high enough to permit observation of this increase or resistance with time. More information on these instruments is in Bulletin 21–20–25. James G. Biddle Co.

8—RELIEF VALVES feature single spring construction

Single spring construction, more accurate valve seating and lower overall height are announced as features of these spring loaded relief valves. The single spring construction is designed to eliminate the superstructure of many multiple spring valves. Design is said



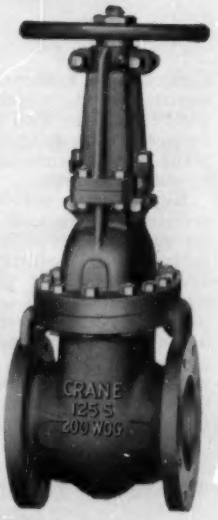
Testing...testing...50 years and longer to make CRANE VALVES maintenance free

Testing for product performance values is an old custom with Crane. It was started long before many standards existed—long before others in the field used this means of product improvement and quality control.

Today's Crane valve testing is done in both field and laboratory by the most scientific techniques. This continuing work seeks to increase valve performance and lessen maintenance needs. A single example is the stem packing test shown above.

Here's one of the reasons back of the thrifty buyers' preference for Crane valves. They can rely on ever-improving Crane quality to protect their company's investments in piping equipment—especially today, in the face of high maintenance and repair costs. No wonder industry keeps using more Crane valves than any other make.

Better Quality
Bigger Selection
in Valves
for Every Need



CRANE CO.

General Offices: 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

CRANE'S FIRST CENTURY . . . 1855-1955

For more data circle 527 on Post Card

to keep spring length at a minimum which, with the large coil diameter and heavy cross wire section, results in a l/r ratio providing spring stability.

Guiding spindles at both top and bottom of the valve disc serve to assure accurate seating, permit use of the valve in any position, and allow installation in either vertical or horizontal pipelines. Use of "reach nuts" bushings threaded at the lower ends — eliminates long spring rods extending above the valve and permits use of rods which do not extend beyond the upper spring plate after compression. Thrust bearings are used under the spring nuts when high relief pressures require greater spring forces. An outer collar around the yoke bushing acts as a stop for the spring plate, permitting the entire yoke assembly to be removed without disturbing the spring assembly and with minimum spring expansion. Schutte and Koerting Co.

9—PROTECTIVE COATINGS for use on metal, concrete

This line of Neoprene based coatings consists of Neobon, an on-the-job mixed heavy rubber coating; Neelium, a high solids high built liquid Neoprene coating; a caulking material and Elprene, a liquid Neoprene maintenance coating. These products which are available in gray and black can be applied to metal or concrete surfaces over a Neobon priming system. Neobon or Elprene may be applied by brush, roller coater or spray. The Atlas Mineral Products Co.

10—ELECTRICAL RACEWAY for heavy-duty wiring

This industrial type of Nepcoduct, an underfloor electrical raceway, is announced as having three times the capacity of standard underfloor duct. A 14-gage cold rolled steel raceway with a 4 by 4 in. cross section, Nepcoduct is

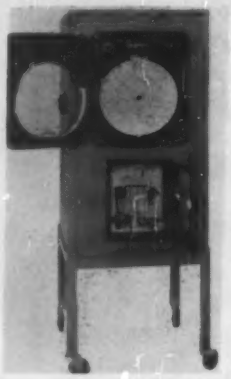
designed for heavy-duty wiring in industrial plants where overhead wiring would interfere with normal operations. Its greater capacity allows flexibility in plant layout, since all areas are served by electrical outlets.

Nepcoduct is galvanized by the sherardizing process and has an acid-resisting clear enamel on interior and exterior surfaces. It is furnished in standard 10-ft lengths and provides 2-in. pipe size, threaded outlets on 24 in. centers permitting the direct insertion of conduit for standpipe service fittings. Complete with junction boxes and a full complement of fittings, the duct is a fully grounded, underfloor wiring system. National Electric Products Corp.

11—ANALYZER UNIT measures dissolved oxygen

To minimize corrosion of boiler tubes and auxiliary equipment, through reduction of dissolved oxygen in boiler feedwater, Model 2B2B Dissolved Oxygen Analyzer is announced for continuous measurement of dissolved oxygen. It consists of a sample flow regulating and ion exchange unit, an analysis unit, and a modified recorder. These may be enclosed in a cabinet mounted on a portable stand, or panel mounted.

Principle of measurement is based on

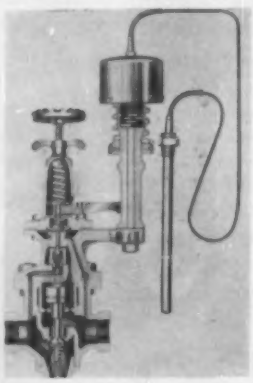


oxidation of nitric acid in water solution by dissolved oxygen to nitrogen dioxide, which in turn reacts with the water to form nitric and nitrous acids. Nitric oxide gas is bubbled into the flowing sample to saturation. Any increase in conductance of water is due to the products of the reaction of NO with dissolved oxygen — the increase in conductance is directly related to the oxygen concentration of the sample.

Model 2B2B has a range of 0 to 20 parts per billion adjustable to 0 to 200 and accuracy is given as 5 per cent of reading. The adjustable range is useful when leaks occur. The range is adjusted to bring the reading on scale, then, as packings, flanges, are tightened, the progress in bringing the process back into control can be followed by means of the adjustable range feature. Arnold O. Beckman, Inc.

12—MODULATING REGULATOR for pressure and temperature

Newest addition to this company's steam and liquid control equipment is the Type PTM Modulating Pressure-Temperature Regulator. As temperature tends to vary, the thermostatic control unit acts upon the pressure regulator to reduce or increase steam pressure, it is



explained; pressure modulates smoothly between intial setting and zero, thereby preventing overrun. Rate of pressure modulation is adjustable to give the user a wide choice of control. Control of temperature is declared much finer.

The regulator has a bronze or semi-steel body, and stainless steel pilot valve, main valve and seat. It comes in six temperature ranges, in sizes of ½ to 2 in. with screwed ends and 2½ to 6 in. with flanged ends. A minimum of 10 lb pressure differential is required to operate the valve. O. C. Keckley Co.

13—GASKETS are designed to permit unrestricted flow

Free Flow Gaskets are designed to eliminate flow restriction and turbulence in the line, as well as danger of gasket rupture at high temperature due to entrapped air between insert and envelope. The inner periphery of this gasket is designed so as not to extend beyond the inner diameter of the pipe to cause a throttling action. This construction assures full contact with the pipe flanges, manufacturer points out, and allows the insert to extend the full depth of the gasket envelope, thereby eliminating an air space.

The envelope is made of chemically inert Teflon. This, it is noted, adapts the gasket to practically all known corrosive services, plus widely varied temperatures from −100 to 482 F. Available in many shapes and sizes, these gaskets are suggested for service in glass lined, porcelain and pyrex equipment, including reactor kettles and pipes, distillation columns and nozzles. Crane Packing Co.

14—CONTROL PANEL is easy to install and service

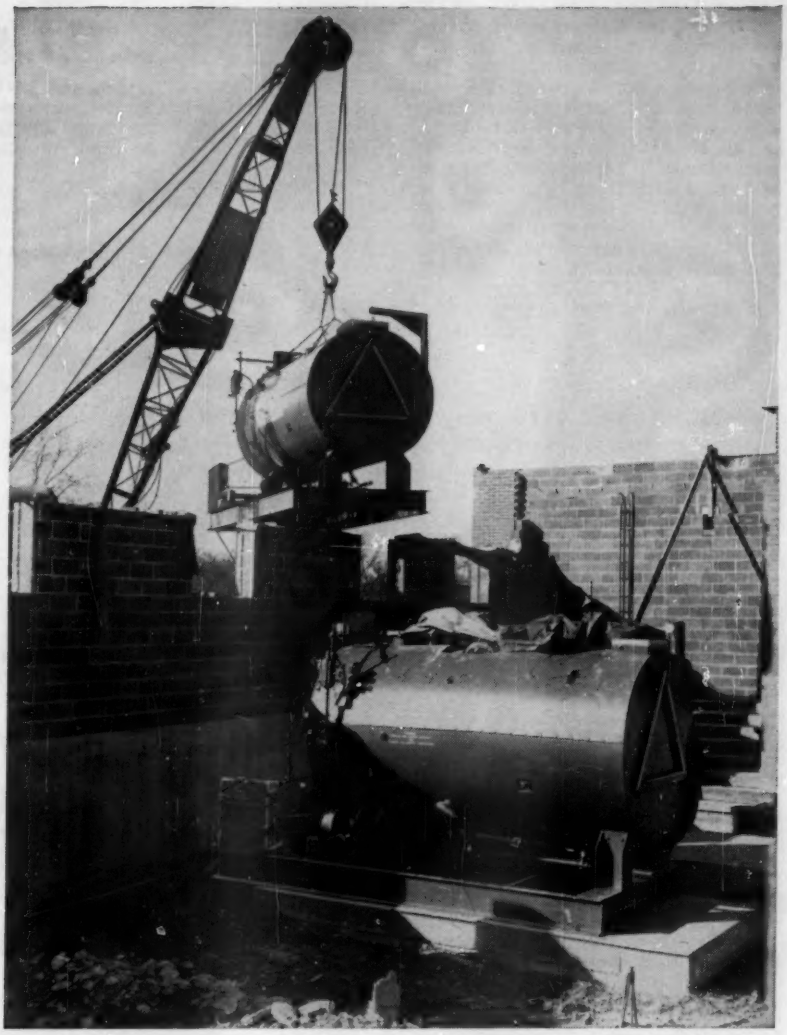
This electronic temperature control panel is announced as easier to install and service because all moving parts are

contained within a single, compact amplifier unit which is held in place by two thumb screws and a plug type electrical connection. No wiring connections need be broken in installation or removal of amplifier unit. The plug type electrical connection suffices. The panel is said to be able to withstand rugged treatment. C. A. Dunham Co.

15—5000-V POWER CABLE is non-metallic sheathed

Through the use of polyethylene insulating compound, and a polyvinyl-chloride sheath, this new cable has a smaller diameter and is lighter than similar cables of equivalent capacity, it is pointed out, and this makes for lower installation costs. At the same time, these compounds provide superior resistance to chemicals, moisture, and to mechanical damage and wear, says company. The cable has three conductors, each individually shielded through its entire length with a metallic shielding. Ground wires, having a total cross section of at least 90 per cent of

FROM START TO STEAM in FOOD PLANTS



...Powermaster® Saves in Many Ways

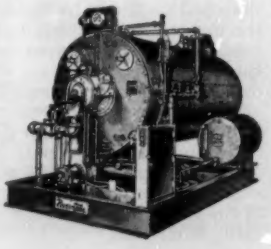
FOR EXAMPLE: Savings with *Powermaster* Packaged Automatic Boilers start with their compact, simplified installation. No special foundation or costly stack is needed. As delivered, *Powermasters* are completely factory assembled and factory fire-tested, fully equipped and wired ready for operation as soon as fuel, electric and flue gas connections are made. Illustrated are two *Powermasters* being installed in a new building under construction.

Once installed, *Powermasters* keep right on saving. High fuel economy at all loads, dependable performance, time-saving attention, maintenance-saving accessibility, automatic operating and safety controls, smokeless combustion, and hospital-clean operation ... these are reasons steam costs go down where *Powermasters* go in.

To keep your steam costs in line ... compare *Powermaster*, and you'll see why it is so widely used in schools, colleges, institutions, industrial plants, and all types of buildings. Send NOW for new bulletins on *Powermaster's* cost-saving advantages.

O-S Powermaster® PACKAGED AUTOMATIC BOILERS

In sizes to 500 HP; pressures to 250 psi.



ORR & SEMBOWER, INC. • Established 1885 • **Morgantown Road, Reading, Penna.**

For more data circle 528 on Post Card

the area of one conductor, are placed in the interstices in contact with the shielding on the individual conductors. Fillers round out the core assembly. The core is taped and then covered with an exterior jacket of polyvinyl-chloride.

This construction is designed to offer the ultimate in protection to personnel, and against lightning. The cable is suggested for installation in boreholes, shafts, horizontal runs in underground entries, aerial suspension on insulators. The cable is made in sizes from No. 6 AWG to 250 MCM. No. 6 AWG, with a rated capacity of 72 amp, is 1.22 in. in diameter, weighs 895 lb per 1000 ft. Rome Cable Corp.

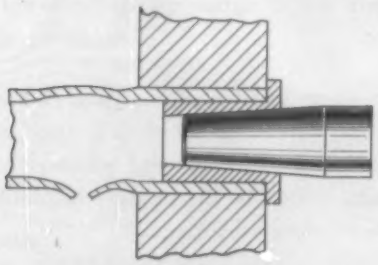
16—LIGHT BRACKETS may be serviced from ground level

Servisafe wall and wood pole brackets are reported to permit safe, efficient ground-level luminarie servicing. Incorporating company's disconnecting and lowering hanger mechanism, the units are designed to eliminate climbing and electrical hazards. In addition, the unit design provides a wide range of application and permits higher mounting for improved area illumination.

To lower luminaire mounted on bracket: open lockbox near wall or pole base and attach a handline to operating cable. Then disconnect the two hanger members with a slow pull and quick release on handline and lower lighting fixture to ground level. Because the live contacts remain in upper member, the lowered part presents no electrical hazards, it is pointed out. After fixture is serviced, it is returned to operating position and re-seated by means of handline. Supplied in complete packages for wiring and erecting, the units can be used with standard pendant and flood type luminaires. Mast arms range from 2 to 12 ft, in 2-ft increments. Guy rod brace assemblies are supplied having 6-ft or longer mast arms, but shorter arm units may be ordered separately. The Thompson Electric Co.

17—TUBE PLUG seals condenser, heat exchanger tubes

For sealing leaky condenser tubes, this sealing plug consists of two pieces; a brass bushing with collar, which is a close fit in the tube (its size must be



specified as the tube inside diameter at the expansion section); and a steel plug, made with a slight taper to fit the inside taper of the bushing, which is then driven into the bushing. The expansion of the bushing or sleeve makes a tight fit, it is claimed, and no damage can be done to the tube sheet. The device is designed to accomplish parallel expansion, and to provide complete contact of the sleeve with the tube. The Lagonda Div., Elliot Co.

18—STEAM TRAP handles light condensate loads

A ½ in. impulse steam trap, the 20-A is especially designed with low capacity to handle light condensate loads. The 20-A will not freeze or air bind on steam

tracer lines, manufacturer points out, and it also gives excellent performance on other light load applications such as small platens, autoclaves, and unit heaters. The unit is described as small in size, low in cost. Its body and working parts are made of stainless steel, and it is designed for pressures to 400 psi. Yarnall-Waring Co.

19—SAFETY DEVICE offers protection for cooling towers

The Dual-Safety Switch is announced as a combined vibration cut-off and safety switch for cooling tower fans. It is designed to protect against both accidents to personnel and extensive vibration damage. According to company engineers, it prevents tower repairs resulting from blade breakage and equilibrium loss on fans. A sensitive mercury switch is provided to automatically stop a fan's electric current when vibration indicates trouble. Sensitivity is set by manual adjustment.

Manufacturer says that in no way can the faulty fan be started again — except by resetting the Dual-Safety Switch after maintenance is completed — and this protects persons working in the fan stacks because it eliminates accidental resetting. The Dual-Safety Switch is operated from the cooling tower deck without entering the fan stack. Its fixed position on the gear supporting beam is aligned for instant reaction to any fan or driving shaft irregularity, it is noted. The device is attached to each fan on this company's cooling towers; manufacturer says it can be used in existing cooling towers. Santa Fe Tank & Tower Co., Inc.

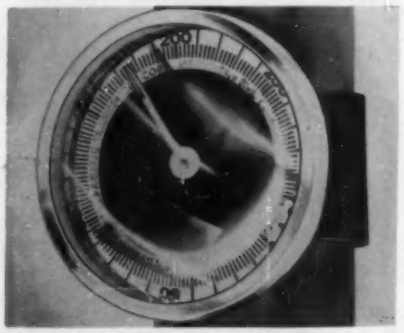
20—MULTI-CYCLONE SYSTEM for improved dust collection

Differing from mechanical dust collectors having a large number of small cyclones in parallel, the Paraclone has a secondary circuit which keeps the discharge from the cyclones under negative pressure. This, according to manufacturer, prevents recycling of dust in the primary system. It is explained that although a few small cyclones, such as used in laboratory tests, are highly efficient, efficiency may fall off when a great many of them are incorporated into a larger single circuit system. This is attributed to unpredictable flow of gases in large ducts, varying pressures, and consequent recycling of substantial quantities of dust. With a secondary circuit, collection efficiency is claimed to be in the range from 0 to 15 microns.

Company engineers report that, taking efficiency into account, the Paraclone is competitive, costwise, with many single circuit systems — and it is adaptable to high- and low-temperature gases, containing small and large abrasive or non-abrasive particles. Other advantages announced include easy installation of the units, and collection efficiency only slightly affected by variations in gas volume produced. Also, the small cyclones are described as highly resistant to wear in handling abrasive particles. It is also noted that in installations where bins for unloading into trucks are located at a distance from the primary system, the secondary one takes the place of a conveying system. Aerodyne Development Corp.

21—SURFACE THERMOMETER for ½- to 2-in. pipes and tubes

This thermometer is fastened to the pipe by a spring clip without use of tools. You merely push the spring over the pipe by hand and the spring snaps into place. The temperature sensitive element is a calibrated bimetal type and is closely



coupled thermo-dynamically to the pipe. The accuracy is given as ±2 deg over the entire range, which reaches stability within 5 min. It is not necessary to open any pipe joints to install this thermometer. The bimetal element is protected by a copper cup designed to fit the pipe closely. Two ranges are available: one from −50 to 250 F and the other from 70 to 370 F. The dial is 2 in. in diameter. The unit costs less than $7.00. The Pacific Transducer Corp.

22—INTEGRATING DEVICE offers simplified operation

A new version of this manufacturer's Integrator — a device for mechanically computing the metered volume of gases, steam or liquids from orifice meter charts — is designed to offer greater capacity, simplified change-over, faster operation and increased resistance to wear. The electrically operated Integrator has a counter setback assembly operating from the main calibration post that lets the operator run practically all ranges of charts at any base pressure, it is pointed out; as a result range settings are almost infinite in number, as compared with the limited number of range holes which could be provided in the older model.

The same setback principle has been applied throughout the machine, elim-

Carrying coal in Delaware Valley with U.S. Rubber Conveyor Belts

(at right) U. S. Giant® Conveyor Belt, carrying coal from car dumper to breaker house.

Panoramic view of part of conveyor belt system utilizing U. S. Giant Conveyor Belting in power plant on the Delaware River.

To feed the four boilers in this power plant in the Delaware Valley, United States Rubber Company conveyor belts, capable of handling 300 tons of coal an hour, take the coal from hopper cars to breaker house to coal bunkers. Like so many other successful belting installations, this one is the result of United States Rubber Company's "Three-Way Engineering" —in which "U.S." engineers work with the engineers of the conveyor system and the power company engineers to turn out the most durable, economical belt system for the specific job. In America and abroad there are thousands of "Three-Way Engineered" jobs, some large, some small —but all steadily keeping output high, costs low. Get in touch with any of the 27 "U.S." District Sales Offices, or write address below.

"U.S." Research perfects it... "U.S." Production builds it... U.S. Industry depends on it

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

For more data circle 529 on Post Card

inating various separate pen centers and pressure range hole segments. Thus, when the machine is in calibration for one make of orifice meter charts, it is in calibration for all makes of charts that the machine will calculate, explains manufacturer. Rockwell Mfg. Co.

23—HEAVY OIL BURNER for the smaller installations

Designed to offer safety and economy features usually found only in larger burners, the new "3" Hev-E-Oil Burner is suited for installation in small commercial, industrial and institutional buildings up to installations having a net standing radiation of 3800 sq ft or 35 bhp. According to manufacturer, the capacity of this oil burner has been increased 56 per cent so that it is now capable of burning 11 gph, and the greater capacity and efficiency are gained with no increase in power consumption.

Like other burners in company's Hev-E-Oil line, the new "3" is a low pressure air atomizing type with all electric ignition. It is designed to burn low cost Nos. 4 or 5 heavy oil without preheating. It is a complete package ready for installation with boiler or heating plant. It is fully wired and ready for service connections. An accessible control box houses the electrical controls. It is pointed out that this burner is inexpensive to install since no front plates, secondary air door or checker work hearth are needed, all primary and secondary air is furnished by the burner. A metering pump dispenses oil, air. Cleaver-Brooks Co.

24—STEAM TRAP is improved thermodynamic type

In this new steam trap, the kinetic energy of steam closes the valve. The only moving part is the valve head — a solid stainless steel disc. This assures practically no maintenance, says manufacturer, and the same head and seat are used for pressures to 600 psi, temperatures to 950 F.

Operating characteristics of the thermodynamic trap are announced as follows: It closes tight on no load and operates against a back pressure up to 50 per cent of its inlet pressure. It discharges condensate at saturated steam temperatures as rapidly as it forms. Also, according to company, this trap can vent large volumes of both air and air-steam mixtures. The starting load capacity is high, but the trap is reported to operate equally well with light loads or no load. Bulletin 355 gives data. Sarco Co., Inc.

26—FUSE CUTOUTS are 50-amp, enclosed units

In this new line of enclosed fuse cutouts all operating functions are available in one basic design. The flexibility is accomplished with one housing and four interchangeable doors in each voltage and current rating. The choice of doors provides for normal duty indicating or dropout, normal duty indicating nondropout, indicating heavy duty or extra heavy duty, and disconnect functions.

In addition to flexibility of operation, the new line will have other advanced design features including; broad-faced, high-pressure V-wedge contacts that are free-aligning, and self-wiping to assure low contact resistance and better alignment; and compression clamping of the mounting support to porcelain housing.

The new cutouts, which help provide distribution system and apparatus protection against short circuits and overloads, are now available in voltage ratings of 5.2 kv and 7.8 kv, in continuous current ratings of 50 amp and in all applicable NEMA Standard interrupting current ratings. General Electric Co.

27—INSTRUMENT guards against excessive machine vibration

For vibration measurement or as a protective device permanently installed on any rotating or vibrating machine, the Model 1 Vibraswitch is said to prevent damage or material wastage from malfunctions causing or resulting from excess vibration. According to manufacturer, an internal SPDT snap switch may be wired into control circuits carrying up to 5 amp to actuate a warning or shut down the machine the instant that the vibration exceeds normal by a preselected amount. The device is claimed capable of actuation with vibratory displacement increases of less than 10 micro-inches at the most sensitive setting. The Beta Corp.

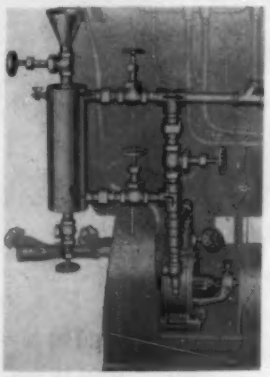
28—COMPACT CONTROLLER provides high braking torque

A d-c braking controller no larger than a combination linestarter, available in two sizes of enclosure for braking standard induction motors from ¼ to 25 hp, is reported to provide braking torques of as much as eight times full load running torque. Operated from a single "start-stop" pushbutton, controller is said to require no adjustment after initial installation. Its main components are a selenium rectifier, contactors, transformer, and a timing circuit.

D-c braking consists of applying d-c to one phase of an induction motor after the a-c voltage has been removed. According to manufacturer, it has these advantages over mechanical braking: faster, more accurate stopping, needs no mechanical maintenance; eliminates need for a double-shaft motor; and eliminates solenoid hum. In addition, d-c braking is said to have advantages over other types of electrical braking: torque decreases rapidly as speed approaches zero, providing smoother, more accurate stops; motor cannot reverse; motor losses are relatively low; and no external motor resistance is required. Westinghouse Electric Corp.

29—BY-PASS UNIT is economical water treatment device

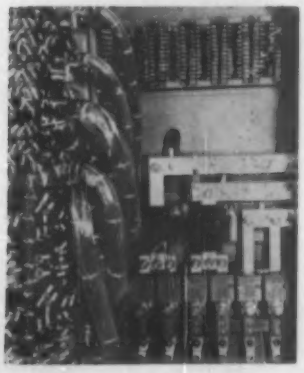
Announced as exceptionally easy to install, the Chemical By-Pass Feeder is for use where water or boiler conditions do not justify expensive mechanical proportioning equipment to treat boiler make-up water. It is designed to avoid excessive feed pump wear by introducing water treatment compounds on the



discharge side of the boiler feed pump. This, according to manufacturer, eliminates the pump wear which may be caused by abrasive materials in the treatment compounds.

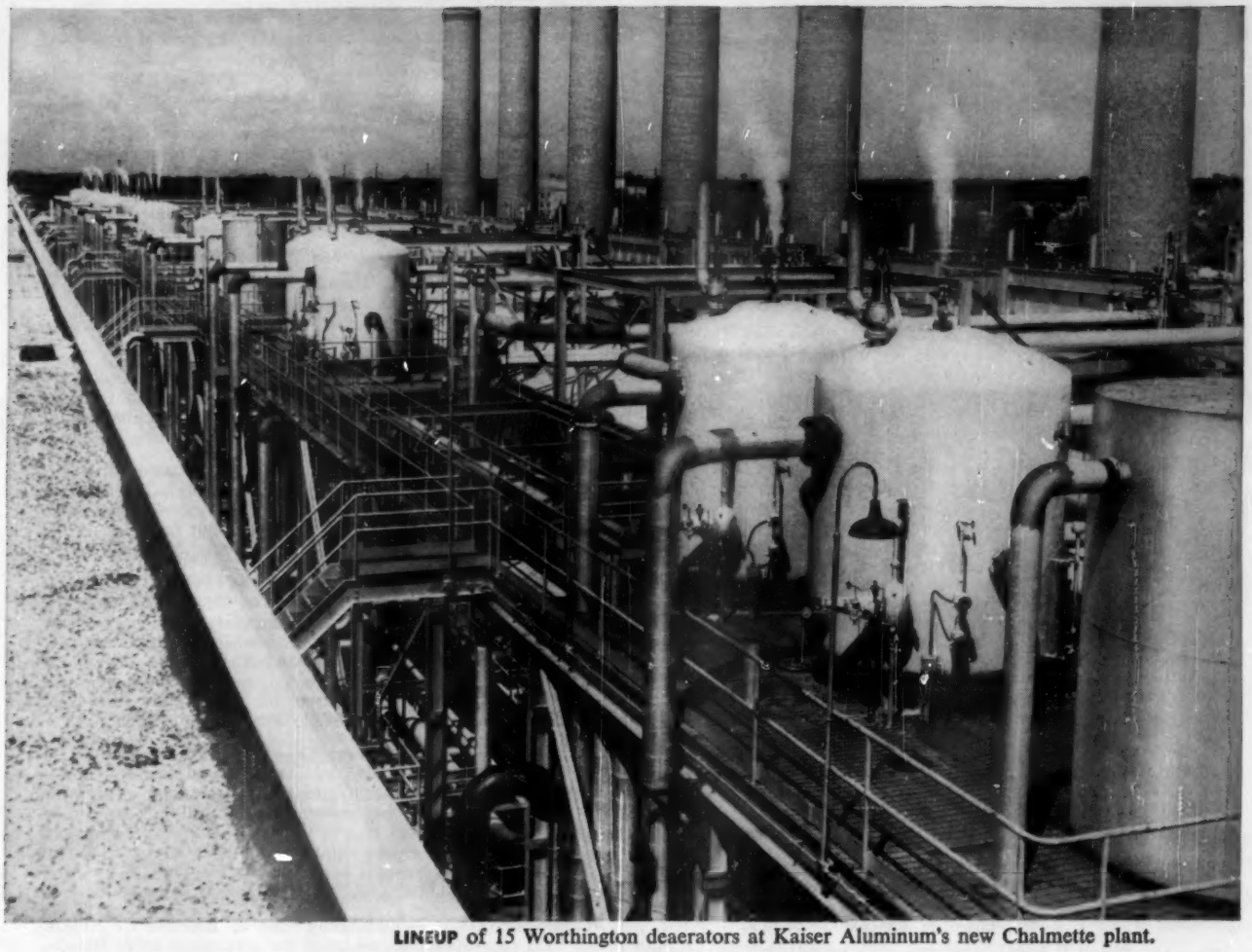
The unit can be used to add either liquid or powdered water treatment chemicals to boiler feed water on any hot water or steam generator. The tank utilized has a 2-gal capacity. With the by-pass design, boiler feed water can be introduced through the tank containing a previously measured amount of treating compound, or by adjusting three valves, it can feed straight through from feed pump to the boiler. This by-pass unit is declared especially suited to low horsepower boilers, installations where make-up water is added infrequently, or in areas where water composition does not require heavy treatment. The by-pass feeder is manufactured of heavy welded steel. Cyclotherm Div., United States Radiator Corp.

25—ELECTRICAL CABLE TUBING is designed to prevent wire chafe



Protektinsul, a prefabricated, poly-vinyl chloride electrical cable tubing, is said to be of substantial value in electrical switchboard panel applications. One manufacturer is reported using it to prevent chafing of wires at hinge points in the switchgear. In this application, the insulated wires are subject to abrasion from opening and closing the doors on the rear of the panels. The Protektinsul Tubing not only prevents wire chafing, it is stated, but because it is clear vinyl, the wires are visible for checking.

Finished to exact size, this tubing needs no cutting, fitting or sewing. According to company, it zips on and locks in place with a closure that assures a watertight and airtight longitudinal joint. In addition to clear, Protektinsul is furnished in standard colors and combinations for identification purposes. Miracle Adhesives Corp.



LINEUP of 15 Worthington deaerators at Kaiser Aluminum's new Chalmette plant.

Biggest U.S. aluminum plant has 15 Worthington deaerators

Kaiser Aluminum's mammoth new reduction plant at Chalmette, La., turns out 12½ pounds of aluminum *every second.*

It takes nearly half a million kilowatts (enough to power a city of 1 million) to sustain Chalmette's rated production of 400 million pounds a year. And the Worthington nameplate pops up everywhere you look in Chalmette's two big powerhouses.

The deaerators are Worthingtons — 15 of them, each with a capacity of 250,000 pounds per hour. These compact and efficient deaerators are of the Full Contact Steam Jet Type. Vent mixture is effectively concentrated by direct contact within the deaerator shell, thus obviating the need for a surface type vent condenser. A troublesome source of maintenance is thereby eliminated, installation is simplified, and cost of lagging is substantially reduced.

Worthington condensers, condensate and circulating pumps, boiler feed pumps and deaerators are all helping to keep Kaiser's Chalmette plant on the line. For the whole story on Worthington deaerators write for Bulletin W-210-B32 today. Address Worthington Corporation, Steam Power Division, Harrison, New Jersey. S.4.3

"SEE the Worthington Corporation Exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 41st Street."

WORTHINGTON

A GREAT TEAM IN STEAM

Steam-Jet Ejectors and Vacuum Pumps • Boiler Feed Pumps • Deaerators • Steam Turbines • Surface Condensers and Auxiliaries

For more data circle 530 on Post Card

CONSTRUCTION NEWS

Tempe, Ariz. — Arizona Public Service Co., Phoenix, Ariz., has plans maturing for new steam-electric generating station near Tempe, where tract of 160 acres of land has been selected. Installation will include a 100,000-kw turbine-generator unit and accessories, high-pressure boilers and auxiliary equipment. It will be known as Ocotillo generating plant and is estimated to cost $12,000,000. Work will be placed under way early in 1955.

Los Angeles, Calif. — Bd. of County Supervisors, Hall of Records Bldg., has plans under way for new steam power plant for central-heating service for county buildings, including distribution lines and other operating facilities. Cost reported about $2,500,000. M. A. Nishkian & Co., 3754 Long Beach Rd., Long Beach, Calif., are consulting engineers.

San Francisco, Calif. — Pacific Gas & Electric Co., 245 Market St., plans new hydroelectric power project on Pit River, Shasta County. Work will consist of a power dam, 150 ft. high, generating station with two hydraulic turbines and generators of 46,000 hp. rating, and auxiliary equipment, including extensions in transmission lines. Entire project is estimated to cost about $17,000,000. Application has been made to Federal Power Commission, Washington, D. C., for permission to proceed.

Colorado Springs, Colo. — Dept. of Public Utilities has plans under way for extensions in municipal power plant, with installation of equipment for increased capacity. Cost reported about $2,500,000. Lutz & May, Finance Bldg., Kansas City, Mo., are consulting engineers.

St. Petersburg, Fla. — Florida Power Corp., has disposed of a bond issue of $12,000,000, proceeds to be used in connection with 1955 expansion and improvement program, including increased generating facilities, power substations, transmission lines and other construction.

Chanute, Kan. — Municipal Electric Dept., will have plans prepared soon for extensions and improvements in municipal steam-electric power plant, with installation of equipment for increased capacity. Bond issue of $1,200,000 has been authorized.

Topeka, Kan. — Kansas Power & Light Co., has disposed of a bond issue of $8,000,000, majority of proceeds to be used for expansion and improvements in generating facilities, power substations, transmission lines and miscellaneous construction.

New Orleans, La. — New Orleans Public Service Co., plans an expenditure of $16,200,000 through 1955 for construction and improvements in generating facilities, power substations, transmission lines and miscellaneous work.

Detroit, Mich. — Detroit Street Railway Dept., 11200 Shoemaker St., plans new power house at shops in Highland Park district, for central steam and heating service. Cost reported over $800,000, with boilers, pumps and auxiliary equipment. H. E. Beyster & Associates, Inc., Industrial Bldg., Detroit, is consulting engineer.

East Lansing, Mich. — Bd. of Trustees, Michigan State College, plans new power house at institution. Cost estimated at $1,850,000, including electric and steam extensions for service at different buildings. Appropriation is included in 1955–1956 expenditure budget submitted to State Controller, Capital Bldg., Lansing, for approval.

Muskegon, Mich. — Consumers Power Co., Jackson, Mich., has authorized further expansion in steam-electric generating plant at Muskegon, known as B. C. Cobb station, where work is now in progress on installation of a 135,000-kw turbine-generator unit and auxiliary equipment. Another unit of like size will be installed, with high-pressure boiler and accessories. Work is scheduled for completion early in 1957. Project will include switching stations, power substations and extensions in transmission lines.

River Rouge, Mich. — Detroit Edison Co., 2000 Second Ave., Detroit, will carry out expansion in new steam-electric generating station at River Rouge, now in course of construction, scheduled for completion in 1956, with rated capacity of 520,000 kw. Installation of a third unit now has been authorized, with rating of 300,000 kw., said to be the largest generator constructed up to present time, with high-pressure boilers, coal pulverizers and auxiliary equipment. Completion is expected late in 1957.

Kansas City, Mo. — Kansas City Power & Light Co., 1330 Baltimore Ave., is arranging financing through sale of bonds to total about $18,000,000, majority of proceeds to be used in connection with 1955 construction program, including generating facilities, transmission and distributing lines, and other work.

Omaha, Neb. — Omaha Public Power District, 17th and Harney Sts., will install a new 100,000-kw steam turbine-generator unit at North Omaha power plant, in connection with expansion at that station, recently noted in these columns. Entire program is reported to cost about $12,000,000. Work will be carried out in 1955. Pioneer Service & Engineering Co., 231 South LaSalle St., Chicago, Ill., is consulting engineer.

Newark, N. J. — Public Service Electric & Gas Co., plans expenditure of $131,000,000 by end of 1955, including additional generating facilities, power substations, transmission and distributing lines, and other construction.

Mineola, L. I., N. Y. — Long Island Lighting Co., is arranging a construction budget of $66,000,000 through 1955, fund to be used for additions to generating capacity, power substations, transmission and distributing lines, and other operating facilities.

Thiells, N. Y. — Bureau of Contracts & Accounts, State Office Bldg., Albany, N. Y., has plans for installation of new equipment in steam power plant at Letchworth Village State Institution, Thiells, to replace existing worn-out facilities. Work will be carried out at once. Cost reported over $100,000.

Charlotte, N. C. — Duke Power Co., 422 South Church St., will carry out two main power projects in 1955, including work at Dan River generating station, now under way, where a new 150,000 kw generating unit will be installed, doubling present capacity; and beginning of construction next spring on new steam-electric plant at Belmont, N. C., recently noted in these columns, for which an initial appropriation of $24,000,000 has been authorized. Financing is through sale of bonds and stock.

Akron, Ohio — Ohio Edison Co., plans an expenditure of about $50,000,000 during 1955 for extensions and improvements in power plants and system, including increased generating facilities, power substations, transmission and distributing lines. Program will include work now in progress, comprising additions to R. E. Burger Generating Station on Ohio River, Belmont County, where capacity will be increased by 270,000 kw, and Edgewater station, Lorain, where 90,000 kw will be added.

Muskogee, Okla. — Oklahoma Gas & Electric Co., Oklahoma City, has awarded contract for structural steel framing for new addition to Riverbank steam-electric generating station, Muskogee, and will proceed with superstructure early in 1955. New generator unit and auxiliary equipment will be installed.

Stillwater, Okla. — City Council has plans in progress for expansion and improvements in municipal steam-electric power plant, with installation of a new 10,000-kw turbine-generator unit and auxiliary equipment. Appropriation has been authorized by bond issue. C. H. Guernsey & Co., 2701 N. Oklahoma St., Oklahoma City, Okla., are consulting engineers.

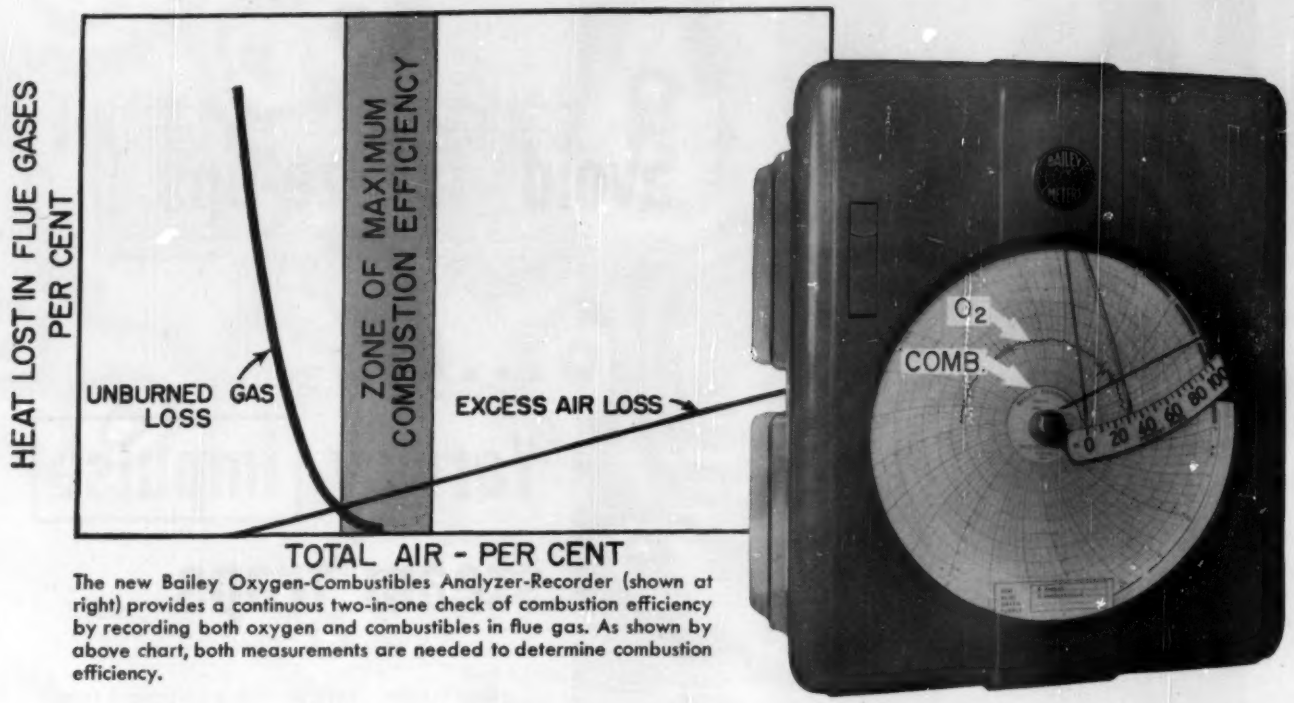
Glen Lyn, Va. — Appalachian Electric Power Co., Roanoke, Va., is awarding contracts for proposed extensions in steam-electric generating station at Glen Lyn and will proceed with program through 1955. Work will include installation of a 225,000-kw turbine-generator unit, high-pressure boilers and auxiliary equipment. Entire project is reported to cost close to $26,000,000, including power substations, transmission lines and other operating facilities.

Yorktown, Va. — American Oil Co., American Bldg., Baltimore, Md., plans steam-generating plant at new oil refinery in York County, near Yorktown. Project will include main refinery, steel tank farm, pumping station and other facilities, and is reported to cost close to $25,000,000.

Yelm, Wash. — City Council, City Hall, Centralia, Wash., has plans for new municipal hydroelectric power plant on Nisqually River, near Yelm, and will begin work soon. It will be known as Unit 7. Carey & Kramer, 1917 First Ave., Seattle, Wash., are consulting engineers.

Appleton Wis. — Wisconsin Michigan Power Co., has disposed of a bond issue of $3,000,000, proceeds to be used in part for construction program, including power plants, transmission lines, power substations and other operating facilities.

Eau Claire, Wis. — Northern States Power Co., 2 South Barstow St., has plans for raising and rebuilding Menomonie dam on Cedar River, Dunn County, with improvements in hydroelectric power plant and installation of additional equipment. Cost estimated about $2,800,000. State Public Service Commission has granted permission. Work will begin soon.



The new Bailey Oxygen-Combustibles Analyzer-Recorder (shown at right) provides a continuous two-in-one check of combustion efficiency by recording both oxygen and combustibles in flue gas. As shown by above chart, both measurements are needed to determine combustion efficiency.

BAILEY announces . . .
New 2 in 1 way to measure Combustion Efficiency

The new Bailey Oxygen-Combustibles Analyzer-Recorder gives you a continuing double check on combustion economy. It's fast response measures and records:

1. Excess air—regardless of the fuel or combinations of fuels being burned.

2. The mixing efficiency of your fuel-burning equipment—by indicating the amount of combustibles in your flue gas, resulting from incomplete mixing of fuel and air.

Combustion efficiency depends upon fuel-air ratio. Too much fuel can be even more costly than too much air. And because of the interdependence of these two factors, no control that measures only one of them can give you complete protection.

Now, for the first time, you can check *both* with a *single* fast acting instrument, using the new Bailey Oxygen-Combustibles Analyzer-Recorder for industrial furnaces, kilns, heaters and boilers.

Fuel economy improves as excess air is reduced —until unburned fuel begins to show up in the flue gas. When this happens, combustion efficiency drops off sharply if there are further decreases in the air-fuel ratio. That's why combustion gases must be analyzed for *both* oxygen and combustibles to get a true indication of efficiency—and that is why Bailey coordinates both measurements on the same chart, to show when excess air may be reduced safely without danger of greater losses from unburned gases.

The Bailey Oxygen-Combustibles Analyzer is an approved combustion safeguard.

Ask your local Bailey engineer for suggestions on application. Equipment details in Product Specifications E65-1 and E12-5. P31-1

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

INSTRUMENTS AND CONTROLS

For Power And Process

For more data circle 531 on Post Card

avoid freeze-ups

... use Yarway impulse steam traps

Don't take chances with equipment freeze-ups and costly production delays. Put Yarway Impulse Steam Traps on all lines subject to freezing temperatures.

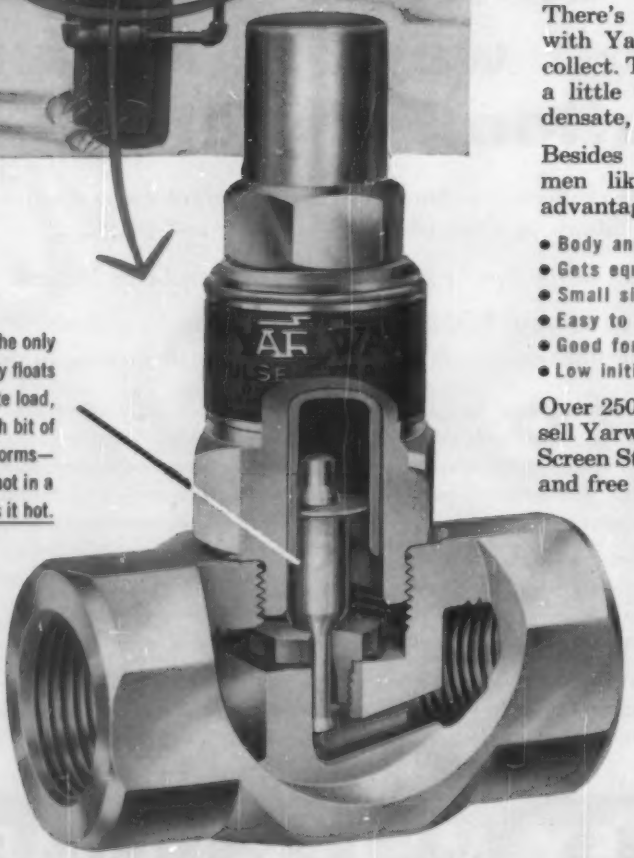
There's no danger of your lines freezing with Yarway traps. Condensate does not collect. The only moving part of the trap—a little valve—continually tests for condensate, discharges each bit as it forms.

Besides this non-freezing feature, plant men like these other Yarway Impulse advantages:

- Body and all working parts are stainless steel
- Gets equipment hot in a hurry and keeps it hot
- Small size . . . light weight
- Easy to install . . . easy to service
- Good for all pressures
- Low initial cost

Over 250 Industrial Distributors stock and sell Yarway Impulse Steam Traps and Fine Screen Strainers. For name of one near you and free trap booklet, write . . .

YARNALL-WARING COMPANY
100 Mermaid Ave.
Philadelphia 18, Pa.



This little valve, the only moving part, actually floats on the condensate load, discharges each bit of condensate as it forms—gets equipment hot in a hurry and keeps it hot.

YARWAY impulse® steam traps

For more data circle 532 on Post Card

In The POWER FIELD

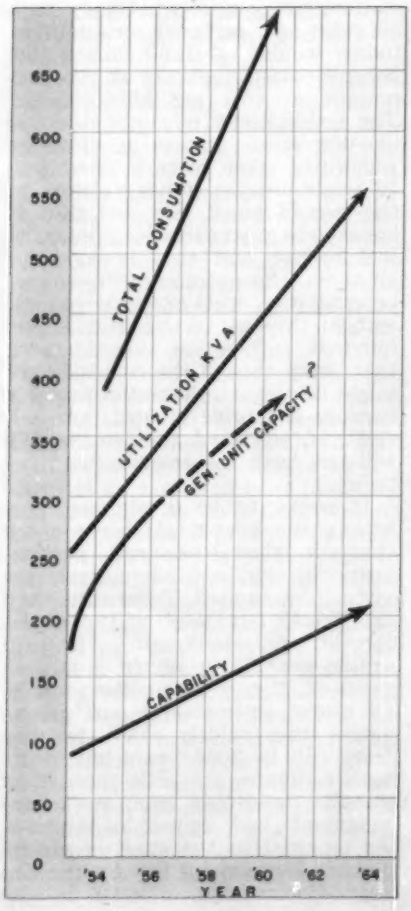
All Trends Continue Upward

ON SEPTEMBER 4, 1882, Thomas Edison started up the first central station at Pearl St., New York City, ushering in the modern electric era. On that day 59 customers received electricity for their new incandescent lamps.

This was 72 years ago — one person's lifetime. In those 72 years electricity has changed the face of the earth. It has brought light, comfort, ease, convenience and health to hundreds of millions of people. It has permeated every aspect of our lives. Without electricity, the world could not support the two and one-half billion people it now holds.

The total generating capacity of Pearl Street Station was 1200 hp—about 900 kw. Each of the Jumbo dynamos was rated 120 kw. In October of last year, 1954, the central station generating capacity of the nation reached the 100 million kilowatt mark. Today we are installing single units of 275,000 kw.

The most astonishing thing about this phenomenal growth of the electric industry is the *rate* at which it is continuing to grow. During the last four decades the installed capacity has doubled every 10 years, and this rate shows no signs of diminishing. Studies indicate that by 1964 the installed generating capacity of this country will reach 200 million kw. What this means is that in the next 10 years we will have to install as much new generating capacity as we did in all the years since 1882 and now. At the same time we will have to build transmission, distribution, and switching facilities to take care of this additional generating capacity. In other words, during the next decade we will have to put into service two national power systems where we now have one.



Because of this continual increase in the demand for electricity, all trends in the industry continue upward. The 275,000 kw generating units now being built will not be the largest, indeed, the manufacturers are quite ready to build 300,000 and 400,000 kw machines. One manufacturer has designs for a 500,000 kw cross-compound unit.

At the same time steam pressures and temperature as well as generator and transmission voltages are still rising. At present the 5000 psi, 1150 F. Eddystone (Philadelphia Electric) cycle is the highest pressure and temperature steam cycle now being developed but pressures of 8000 psi and steam temperatures of 1200 F hold promise for future development. These higher pressures and temperatures, of course, also mean higher thermal efficiencies.

In terms of human values, all this means more leisure, more comfort and pleasure —more time for Beethoven or baseball. Today we have some 39 hp per capita. What we will have 25 years hence is anybody's guess but it will be very large.

Andrew C. Kramer

Our Fuel Reserves Won't Last Forever

Despite the remarkable advances in the thermal efficiencies of our power stations, the rate at which we are using electrical energy and the consequent demands on our fuel resources, make it increasingly necessary to look to new sources of energy to serve mankind in the years to come.

THE YEAR 1954 was of particular significance to the power industry because it was the Diamond Jubilee of Edison's invention of the incandescent lamp. Every so often in the course of history a giant keeps his date with destiny and the world becomes a better place to live in. Thomas Alva Edison was such a giant. It was fitting, indeed, that we should have taken last year to celebrate the 75th anniversary of his greatest contribution to our well-being.

The first little Jumbo dynamos installed in Pearl Street Station in 1882 bear little resemblance to the 275,000-kw streamlined giant generators of today, but they had within them the vital force which made today's huge machines possible.

It is almost impossible to realize how far the industry has come since those early days. The one million dollars that Edison first raised for his company gave birth to today's *25 billion* dollar industry. On September 4, 1882, the day Pearl Street Station began operation, Edison had 59 customers. Today, with over 97 per cent of the nation's families using electric service, the industry has 50 million customers. Interconnected systems now include more than 150,000 miles of transmission lines operating at voltages from 66,000 to 330,000, with lower voltage transmission and distribution circuits many times that length. And, this year, this vast transmission and distribution network is served by generating plants totaling over 100,000,000 kilowatts — more than 40 per cent of all the electric power in the world.

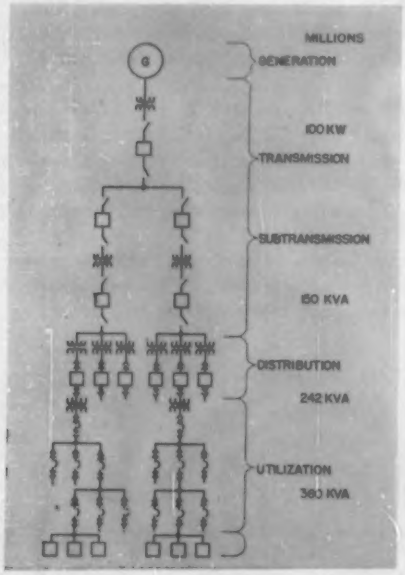


Fig. 1. This diagram shows the relation between generator capacity and the installed kva necessary for transmission, distribution, and utilization equipment

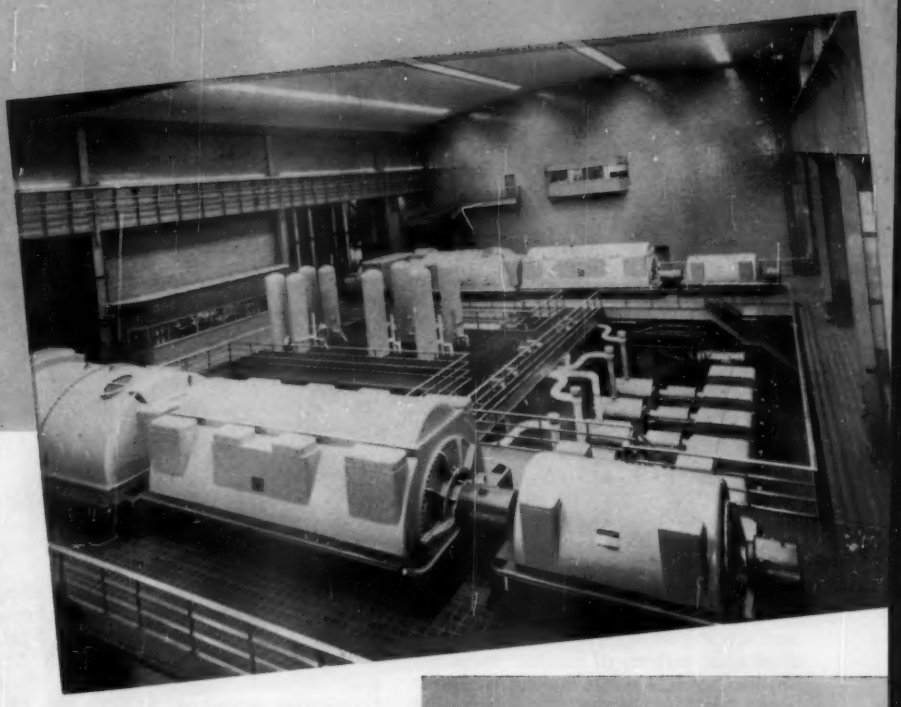
While this 100,000,000 kw in generator capacity represents a tremendous quantity of equipment in the generating stations, it implies a much greater quantity (in terms of kva) of transmission, subtransmission, and utilization equipment in factories and homes. This is shown by the accompanying diagram. As will be noted, for every kw of generator capacity it is necessary to install 1.5 kva of subtransmission equipment, 2.42 kva of distribution equipment, and 3.66 kva of utilization equipment.

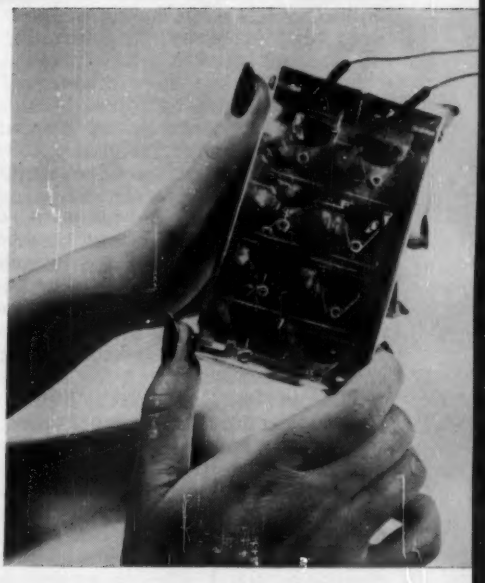
These figures are of particular significance when we consider the rate at which the generating capacity of the country is growing. It is an established fact that the generating capacity of this country has been doubling every ten years during the last four decades. Studies indicate that this same rate of growth will prevail during the next decade, which means that during the next ten years we will not only have to install as much generating capacity as we now have, but in addition we will have to provide transmission, distribution and utilization equipment in the ratios given in the preceding paragraph.

By 1970 the capability of the nation's electric generators is expected to reach a value somewhere around 300 million kilowatts but as has been the case with forecasts in the past, this forecast will probably be low rather than high. History of the industry over the last 50 years has shown that regardless of wars, depressions, recessions, political or social conditions, the demand for electricity continues to rise steadily.

Last year, 1954, we used a total of around 400 billion kilowatthours. By 1970 we will be using in the neighborhood of 1200 billion — three times as much as we are using today. This is an interesting figure because it has something to do with the development of atomic energy for power. At present the national average for the rate of power production is one pound of coal per kilowatthour. This means, then, that in 1954 we used a total of 400 billion equivalent lbs of coal to produce the electrical energy in the United States. The way things are, the coal industry has no trouble in supplying this amount of coal, indeed, it would like to supply much more. If the thermal efficiencies of our power stations today were what they were 30 years ago, our coal consumption today would be 1200 billion lbs because at that time we used 3 pounds of coal per kilowatthour. The coal industry, no doubt, does not like the great increase in efficiency which has taken place in these last 30 years because it has resulted in the sale of much less coal. But it has saved a great deal of our potential fuel reserve and that is good for all of us. However, in 1970, we *will* be using coal, or its oil or gas equivalent, at the rate of one trillion, two hundred million lbs annually and, then, even though the coal industry might be pleased, the rest of us won't because the price of coal, and oil, and gas, will tend to increase. We will not have the reserves we have today.

It seems to be a common idea among the people of this country that our mineral resources, particularly our coal and oil reserves, are virtually unlimited. To be sure, they are great, but they will not last forever, and whether it be in 1970 or the year 2000, which is only 45 years off, they will be getting scarce. Of course, estimates of our fuel reserves vary widely — all the way from 150 to 3000 years but many such estimates are little more than guesses, depending upon one's temperament and economic interests. As reported in the study made by Palmer Putnam for the Atomic Energy Commission, officials in one





THREE STAGES IN POWER DEVELOPMENT

Above, at the left, is shown an old Edison Jumbo dynamo—the type of electric generator used in Pearl Street Station. At the right is the turbine room of the new Kearny (N. J.) Station showing the 145,000-kw single-shaft generators, the last word in the production of electricity. Below, at the right, is a picture of Bell Telephone Lab's new solar battery for converting the energy of sunlight directly into electricity. Will this be our power station of the future?

branch of the government estimated that the reserves of coal would tide the United States over for 1000 years. Other officials had suggested that the coal reserves would not last more than a few hundred years; and individuals within the industry were confident that shortages would occur before 1970.

There is a tremendous difference of opinion on this subject, as well as on other types of fuel reserves. The Smythe report had stated that the supply of nuclear fuels is limited. A widely read member of the petroleum industry had asserted that nuclear fuels would never be more than a minor and transitory source of energy. An advisor of the Atomic Energy Commission, on the other hand, had seen no limitation to the availability of nuclear fuel.

Perhaps the only measure we can apply to this situation is common sense. It should be obvious that the mineral resources of this planet are limited; if we continue to use them at an ever increasing rate they will come to an end. Coal and oil are not replaceable in the generations of man. The saving in fuel due to the continual improvement in the thermal efficiencies of our generating stations has saved a tremendous quantity of coal over the last 30 years, but it is unlikely that further improvements in efficiency will result in similar savings. We are getting closer and closer to the point of diminishing returns, and it is unlikely that with our steam power stations we will greatly improve the efficiencies we have now attained. Unless we manage to circumvent the second law of thermodynamics we cannot expect to go very much further than we have in increasing thermal efficiency.

It is for this reason that we must look toward nuclear energy and, ultimately, towards solar energy. It is quite obvious that our resources of fissionable material, that is uranium and thorium, are considerably greater than was generally believed only several years ago. At the present time, it is more or less generally accepted that the fissionable material resources of the earth exceed the fossil fuel resources (coal, oil, and gas) by some 20 to 30 times.

In many countries of the world, indeed in most of them, excluding Soviet Russia, the coal, oil and gas resources are already scarce. This, of course, excludes undeveloped countries such as Arabia which has vast fuel oil reserves. These countries, therefore, have a much greater incentive towards the development of atomic power than we have, and it is quite likely that some of these countries will have practical atomic power before we have.

Of course, in the end, we will have to come to the direct use of solar energy. The power from the sun is the only unlimited source of energy that we have, and curiously enough, that is by far the greatest source at our disposal, provided we learn how to use it. It is significant that a great deal of interest is being shown in solar energy at the present time. A world solar power conference is being held in Arizona this month, and as explained in other pages of this section, a considerable amount of research is being directed toward the development of devices which can convert solar energy into electricity.

The development of the electrical industry outranks all other achievements of the human race. As has been pointed out, perhaps the whole thing is a phenomenon the like of which will never occur again, unless it was the establishment of a nuclear chain reaction by Dr. Enrico Fermi on December 2, 1942, twelve years ago last month. The success of that experiment may even overshadow the advent of the electric power industry. We shall see.

Highlights of Atomic Power

Change in the basic atomic energy law enacted during the year and AEC's Five-year reactor program have stimulated interest in atomic power development. So far, however, industry has not shown the aggressiveness needed if we are to retain world leadership in atomic energy field. Foreign development going ahead on all fronts

By ANDREW W. KRAMER
Editor, POWER ENGINEERING

NINETEEN-FIFTY-FOUR has been a significant year in the field of atomic power because it was the first year in which the national emphasis shifted substantially from interest in atomic weapons to serious concern about atomic power. Interest in atomic power, of course, does not imply any less effort in the weapons field; this, evidently, is continuing full blast but we seem to have reached a point where the sheer pressure of events has begun to force the development of atomic power despite considerable commercial lethargy.

There has been a tremendous surge of interest in atomic power among industrial organizations. Manufacturing companies have set up atomic power divisions and several firms are offering experimental reactors for sale. At the same time regional influences are promoting the formation of company groups to develop atomic power in certain areas.

Thus, in New England, the Yankee Atomic Electric Co. is being formed, and in the northwest, five electric companies are proposing entrance into this field in a large way. One of the significant events of the year was General Electric's enthusiastic prediction that within 10 years electric companies would be operating atomic power plants at costs competitive with conventional fuels. Power costs of 6.7 and 6.8 mills per kilowatt-hour were predicted, perhaps in 5 years, certainly within 10 years.

Of great influence in stimulating this growing interest in atomic power was the predicted change in the basic atomic energy law, enacted on August 30, and the AEC's $242-million five-year reactor program. The launching of the atomic submarine, Nautilus, on January 21 also helped to create interest in atomic power. The Nautilus, of course, is a naval weapon; its primary purpose is war, not peace, but this submarine brings to reality the world's first working atomic power plant. The principles which underlie its power plant can be used in peacetime power plants, indeed, these very principles are now being built into the first U. S. commercial atomic power plant — the Duquesne-Westinghouse plant at Shippingport, Pa. Ground for this plant was broken on Labor Day.

An interesting aspect of the growing interest in atomic power is the formation of new technical and commercial societies. Thus, the Nuclear Engineering Division of the American Institute of Chemical Engineers was formed. Although a division of the AIChE, membership in the parent society is not required for membership in the Nuclear Division. Anyone interested in the field is eligible. Dues are $2.00 a year. The Engineers Joint Council, composed of major American engineering societies with a total membership of 170,000 is also endeavoring to form a nuclear engineering group. The Atomic Industrial Forum, composed of manufacturers and utility executives has been in existence for some time.

The AEC Five-Year Program

The five-year power reactor program developed by the Atomic Energy Commission is of immeasurable importance because it will provide basic data and experience needed before the technical and economic feasibility of commercial nuclear power plants can be assured. The program provides for the development of 5 distinct technological approaches with experimental reactor power plants costing nearly $200-million, and outlines general research and development activities costing about $8.5-million annually over a 5-year period. Since the attainment of economic nuclear power is of vital importance to the nation, the AEC proposes to develop the five reactor types which seem most likely to achieve this goal. These are set forth in the accompanying table.

Of these five types, the pressurized water reactor (PWR) being built by Westinghouse and to be incorporated in the Duquesne Light Co. plant at Shippingport, Pa., will be the only full-scale plant. It will be the nation's first civilian nuclear power plant. It is scheduled for completion in 1957 but before that Britain is scheduled to start up its first atomic power plant at Calder Hill about the middle of 1955.

PWR, as already mentioned, is similar to the reactor powering the Nautilus. It is a water-moderated and cooled reactor using slightly enriched uranium fuel. While this plant

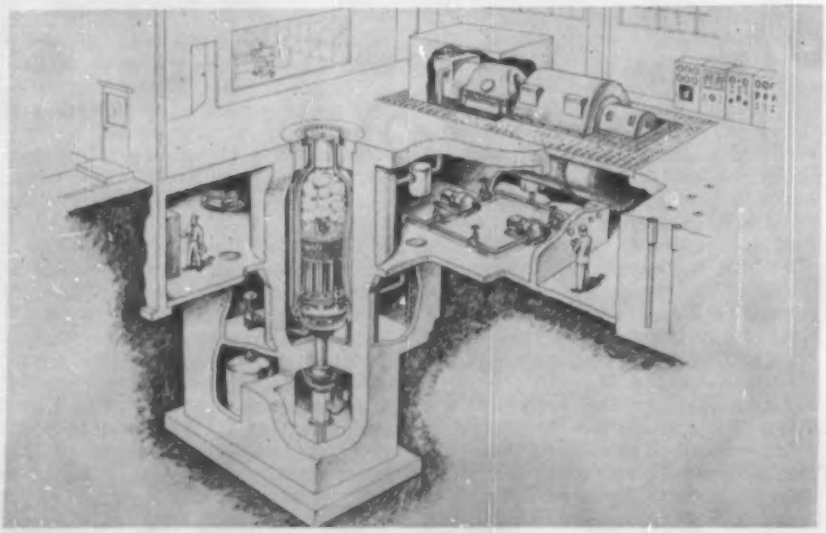


Fig. 1. A sketch of the steaming reactor power plant based on experiments carried on by Argonne National Laboratory. Steam produced in the reactor pressure vessel is delivered to the turbine without intermediate heat transfer

Development in 1954

Fig. 2. This partial view of The University of California's Bevatron reflects the magnitude and the dramatic aspects of modern nuclear research. This, the world's most powerful particle accelerator costs $9 million and will accelerate particles to a maximum energy of 6.25 billion electron volts

is not expected to produce power at competitive costs, it was selected for the first full-scale plant because more is known about this type reactor than other types. It will have a power level of 300,000 kw of heat and an output of at least 60,000 kw of electricity.

Perhaps the most interesting reactor in the AEC 5-year program is the experimental boiling-water reactor in which the steam for the turbogenerator is produced in the reactor core itself. It was formerly believed that boiling within the core of a water-cooled reactor would cause unstable operation. Experiments conducted by the Argonne National Laboratory at the National Reactor Testing Station in Idaho during the summer of 1953, however, indicated that this was untrue. The tests, furthermore, indicated that a boiling-water reactor would be self-regulating — it could not "run away."

The proposed boiling-water reactor plant based on these experiments will produce 20,000 kw of heat, and 5000 kw of electricity and is expected to be completed during the winter of 1956. A sketch of this type of plant is shown in Fig. 1. Steam from the reactor vessel at, say, 500 psi goes directly to the turbine. The slight radioactivity of the steam is not expected to give too much trouble, though corrosion contamination could present difficulty in this respect.

The sodium-graphite reactor to be completed in 1955 will be designed to produce 20,000 kw of heat but no electric generation. The advantage of the sodium-cooled reactor lies in the fact that nowhere in the system is pressurizing necessary while at the same time high temperatures can be expected. This leads to higher efficiencies. Corrosion data indicate that temperatures up to 600 C (1112 F) for the exit coolant from the core are possible.

Speaking at the International Congress of Industrial Chemistry at Brussels in September about these reactors, Dr. Walter Zinn, Director of Argonne National Laboratory said that it was the great difficulty of finding a proper protective sheath for the uranium of the first plutonium production reactors which, in 1946, led him to become interested in sodium as a reactor coolant. Fig. 4 is a sketch of a sodium reactor plant presented by Dr. Zinn. The particular merit of this design lies in the novel arrangement of reactor and primary cooling system, which is called the "tank type."

The reactor core is housed at the center of a large tank containing liquid sodium. The core is surrounded by a shield to reduce the neutron intensity outside it to *machine* tolerance — not human tolerance. Outside the shield but within the main tank are pumps and heat exchangers. The sodium from the tank is circulated through the reactor core and heat exchangers, where heat is delivered to a second liquid metal, probably sodium-potassium alloy. All the radioactivity is confined to the single container, and there are no pipes which could fail and give rise to a serious radioactive fire.

Another sketch of a sodium-cooled plant is shown in Fig. 3. This sketch presented by Dr. Chauncy Starr, manager of North American's Nuclear Engineering and Manufacturing Department, is of special interest because it is, so far as we are aware, the first atomic power plant design based on the use of *two* reactors. This plant would produce about 200,000 kw of electricity.

The homogeneous reactor has intrigued scientists because of its inherent simplicity and the possibility of continuous economical fuel processing of the spent fuel. In 1953, Oak Ridge National Laboratory placed in operation its Homogeneous Experiment No. 1. This first power reactor of this type circulated uranyl sulfate fuel solution at nearly 500 F under 1000 psi and at a power density of 30 kw per liter. It had a heat output of 1000 kw, and ran a small turbogenerator.

It was the success of this experiment that led the AEC to choose this type of reactor as the fourth step in the 5-year program. The reactor just described (HRE No. 1) was dismantled in the spring of this year to make way for the construction of Homogeneous Experiment No. 2. This unit will have a heat output of 5000 kw and it is expected to be completed and placed in operation in 1955. Its primary purpose is to produce a sim-

Table Outlining AEC's 5-Year Program

Project (Research, Development, and Construction)	Estimated cost*	Estimated completion	Experimental scale
	Million		
1. Pressurized water reactor	$85	1957	Full.
2. Boiling water reactor	17	1956	Medium.
3. Sodium graphite reactor	10	1955	Medium.
4. Homogeneous reactor	47	1956–58	Medium.
5. Fast breeder reactor	40	1958	Medium.
Total	199	5 years	

*All costs estimates are conditional on annual congressional appropriations.

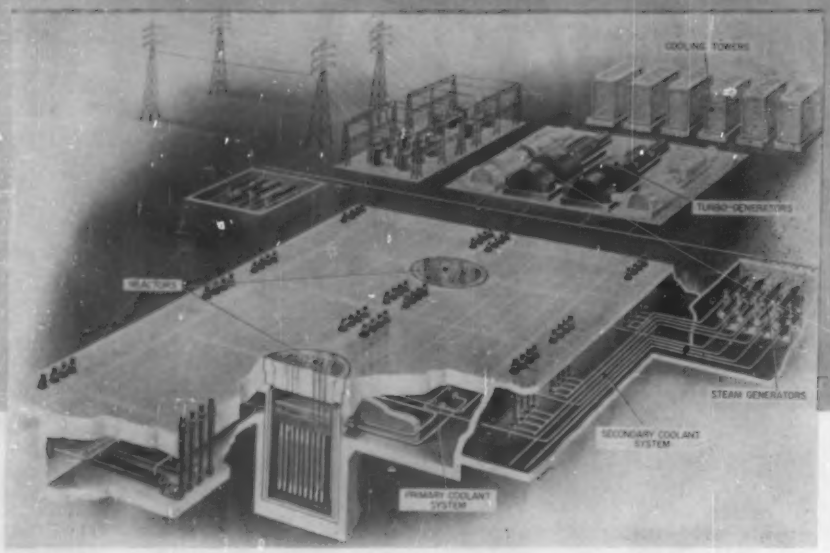


Fig. 3. Artist's sketch of North American Aviation's design for a sodium graphite reactor atomic power plant. This design is of particular interest because it utilizes two reactors. This plant would develop 200,000 kw of electricity

plified, mechanically reliable plant demonstrating operability and reliability over a long period under conditions closely simulating those of a full scale reactor. It will furnish steam for a small turbogenerator and the plant will include chemical processing equipment for the purification of the fuel solution by removing the fission products.

Finally, the AEC program involves the construction of a new Experimental Breeder Reactor, based on the two years operating experience with the first breeder reactor in Idaho. EBR No. 2 will be a scale-up to 62,500 kw in heat power and 15,000 kw in electrical energy. This plant will closely resemble a central station power-breeder reactor in power, control, fuel handling, and other features.

Industry Participation

So much for the government program. It is obvious that the government is doing everything possible to encourage industrial participation in developing atomic power in this country. A tremendous amount of useful technical data has been, and is still being, released and vigorous moves are being made to put much of the government reactor information into what is being called the "L" category — a limited clearance category.

It will be possible also to move further in declassifying information for American industry, but AEC officials have pointed out that there is no point in declassifying more information if only European industry and Russian industry make use of this information. There is no sense in declassifying information if no one in this country uses it. For, despite the general interest in atomic power, so far private industry has not started construction of any actual plants.

During the past several years many industrial study groups have been at work evaluating the merits of various classes of nuclear plants but, so far, this has been all paper work. Dr. Lawrence Hafstad, director of the AEC Reactor Division, was very emphatic about this in a recent address before the Atomic Industrial Forum. "We have been talking reactors and power reactors for three years now in connection with the industrial study program. All the while it was well known that changes in the law were coming along. We knew roughly what the law would contain. The law has now been passed and signed. If industry is as aggressive and enterprising as we like to think it is, why hasn't some company come up with a plan under the new law — a plan they're ready to move on?

"Instead, industry is saying, 'At last we have a law under which it makes sense for us to start thinking seriously about building reactors.' It will cost the nation several years if this leisurely approach is taken. The new law permits *action* at the present time. We had plenty of time to study under the old law. If we are just starting now to study seriously, several years will be lost. I can assure you that people in other parts of the world are not losing this time.

"We need action now. We need aggressiveness if we are to compete with European nations. Equipment suppliers and utilities both say they are ready but nothing happens. Today we should be *building* atomic power plants. We have passed the time when we can get along with paper studies and economic analyses."

Dr. Hafstad said that he was aware that there is no great amount of money to be made immediately in this new field — no way for anybody to get rich quick. While it is prudent for industrial magnets to safeguard their stockholders' money, it is also good business to safeguard their interests by not missing any bets. If there is anything at all to this atomic energy business, then industry ought to push hard and find out what the answers are. Industry should not be willing to let government organizations just coast with this thing, piddle with it over the years, and eventually decide it cannot be done.

"The reason for this," said Dr. Hafstad, "is that if the nation really needs the brains and imagination of American industry to get the answer, then American industry ought genuinely to get into atomic energy and see what the future really is. If there is no future, it ought to be learned quickly so that we can stop the whole business. This is a very expensive experimentation we're engaged in."

"Put it another way. If we can get $10,000 a year government brains to provide the imagination and to take the initiative in this program, then what are all the high-priced vice presidents in industry for? If, with civil service brains, we can solve the really difficult development problems in this field, I am sure that under government auspices we can get people who can handle the operating problems. They will be a lot simpler."

Foreign Atomic Development

Foreign atomic energy development differs from U. S. development in that the projects are on a much smaller scale because the available resources are far less than ours but the character of the scientific development is just as good, and frequently superior to our own. This is particularly true of European practice. They may not have the money we have but their brains are just as good.

In many instances, the European theoretical and experimental research is of a higher order of accuracy than ours. One of the reasons for this is that many of our measurements of, say, fundamental pile neutron constants, were hastily made in the period 1940–1944, when there simply was not enough time for lengthy, detailed investigations. Being classified, the Europeans assume that we know all about these matters but since they are not available they are compelled to do their own research in search of these values. Having more time, in many cases they have more accurate data than we have. Also, not having

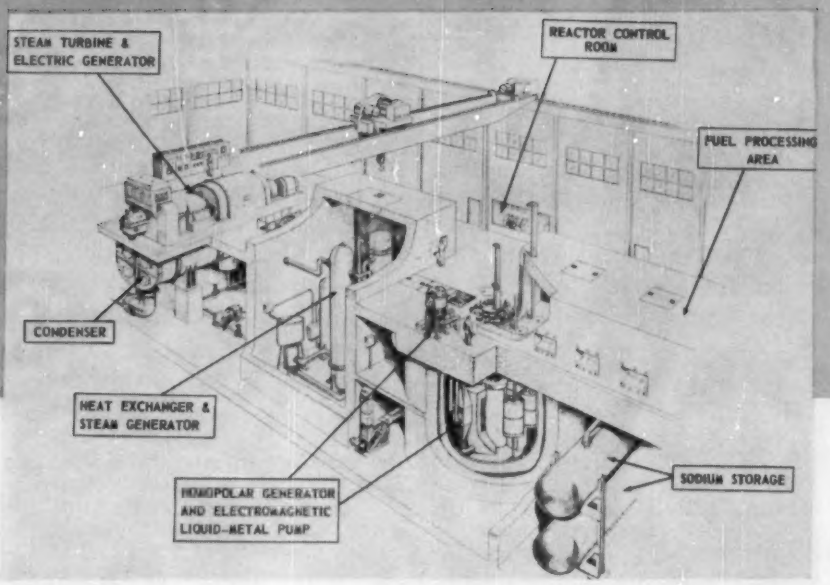


Fig. 4. A sketch of the sodium cooled reactor described by Dr. Zinn of Argonne National Laboratory at Brussels, Belgium in September. This uses the "tank-type" primary cooling system in which all the radioactivity is confined to a single completely shielded container

the money to engage in the construction of large reactor installations, they concentrate more on basic research.

As a result, European scientists are accumulating a vast quantity of valuable data which will be useful when they begin actual construction of large atomic power plants. Indeed, the ingenuity reflected in the design of many of the European research reactors is truly astonishing. At the same time, there is a great amount of coordination and exchange of information between the research groups of the various European countries — there are fewer security restrictions.

During the year, federal atomic energy agencies in eight European countries formed the European Atomic Society with Sir John Cockcroft of Britain as president and Gunnar Randers of Norway as executive vice president. In Belgium, construction was started on a 3½-Mw graphite-moderated reactor using U. S. fabricated natural uranium fuel elements. For diplomatic reasons, the U. S. has tried to keep the transfer of these fuel elements quiet. A good deal of the uranium for our own reactors comes from the Belgium Congo.

Holland and Norway are planning to combine on another reactor project — a $7.4-million project using a pressurized heavy water reactor of 10,000-kw capacity to serve as a prototype for a merchant ship plant. The reactor would be built in Holland, with the costs borne by the Dutch and the Norwegians supplying the fuel. In Sweden this first nuclear reactor began operations on July 13 at a power level of 1 watt. This reactor, however, will be run at 100 kw.

On the opposite side of the world, plans are being accelerated to build the first nuclear power station in Australia. Latest proposals aim at incorpoating this station in the $1-billion Snowy Mountains Hydroelectric Scheme. South Australia's $11.2-million uranium mine and concentration plant at Radium Hill was expected to be in full production in December, and the first exports of high-grade uranium oxide to Britain and the U. S. will be shipped early this year.

In France, the second experimental reactor — the Scalay reactor — has been in operation for some time at a 1000-kw level. An extremely interesting feature of the Scalay reactor is the fact that it uses both water and nitrogen cooling. France's present atomic "Five-Year Plan" aims at enlarging the industrial scope of the national atomic effort and to bring France to the threshold of a paying power production.

European Activity

As far as foreign development of atomic energy is concerned, contrary to the general impression in this country, the Europeans in particular are very sophisticated in the atomic energy field. As Dr. Hafstad has pointed out, the Europeans don't need our secrets to make progress in this field.

We like to believe that we have a great reservoir of secret technical facts from which we release information, declassify information from time to time, and that our industry and European industry are very grateful for these crumbs of knowledge that come out of our great reservoir. That is a misconception. We do have a reservoir of experience or what is often called engineering know-how. Our reservoir of facts is almost dry, and the Europeans have all the technical and scientific knowledge they need to make progress. Furthermore, they have a great deal more incentive to be serious about this field than we have in this country because of their higher fuel costs.

We, therefore, can expect the Europeans to take a very aggressive part in the international pool arrangement. The Europeans are interested, not in getting our research reactors — they built their own research reactors and are thoroughly competent in that field — but in building power reactors. They will be prepared to compete with American industry for the market in the undeveloped countries, first for research reactors, then for power reactors.

A great amount of research and development in all phases of nuclear science is going on throughout the entire world. This research involves not only atomic power but the use of radioactive materials in industry, medicine and biology; indeed, compared to research in the field of power reactors the research in the biological and medical fields is extremely complex.

In industry the prospect of using nuclear radiation to bring about chemical reactions holds great promise, and in this field it is interesting to know that the Standard Oil Co. (N. J.) is planning extensive research in this direction. The cold sterilization of food also offers a fertile field for the use of nuclear radiation and the experimental work being carried on at the University of Michigan on the irradiation of pork may bring about the eventual control of the disease, trichinosis in this country.

In the field of reactor development, perhaps the most interesting as well as one of the most promising ideas is the Liquid Metal Fuel Reactor System announced by Brookhaven National Laboratory at the International Congress on Nuclear Engineering at Ann Arbor, Mich. in June of last year? This system utilizes a liquid-metal solution of bismuth and uranium which functions both as fuel and heat transfer medium. A great deal of research and development has been done on this type of system by the Brookhaven staff because it offers many advantages over systems using solid fuel elements. Among these advantages are high specific power, high operating temperature without high pressures, good neutron economy to provide breeding, simple construction, cheap chemical processing, lack of radiation damage to fuel, and easy and effective removal of fission products.

Progress in Power Plant Details Paces Upward Trends

Year in steam engineering marked by: new turbine units up to 300,000 kw; second supercritical pressure unit, 275,000 kw, 5000 psi, 1200 F; more reheat; more pressurized and forced circulation boilers; more outdoor units; more smaller industrial boilers; more thermal efficiency; more gas turbines; better auxiliaries

IN THE PRECEDING pages, you have seen how the general trend of technical developments in the power field, in capacities of units and in pressures and temperatures and efficiencies, is ranging continuously upward. The year 1954 has been marked by several developments representative of these trends and they will be outlined briefly here.

One of the most spectacular announcements made during the year was the proposal of Philadelphia Electric Co. to build a 275,000-kw 5,000-psi, 1200-F power plant, noted in the September issue. This is the second of the supercritical power plants to be announced. First one announced was the 120,000-kw plant to be installed at the Philo Station reported in July 1953 and January 1954.

Many other large but conventional units, of capacities ranging between 150,000 and 200,000 kw are also being planned, and one company is having two units of 260,000 kw capacity each constructed for a new plant. However, designers are talking optimistically of units up to 300,000 or 400,000 kw and even up to 500,000 kw capacity to meet the increasing load demands expected in the new few years. In fact, as this goes to press, word comes that one of the large turbine generator manufacturers has contracted with a Midwest utility for a 300,000-kw, 2400-psi unit.

For most of the new large units, the one-boiler-per-turbine design prevails and steam generating units for outputs of 1,000,000 lb per hr and upward will become quite common. Two boilers will generate over 1,700,000 lb per hr each. At the other extreme are the hundreds of boilers being installed in industrial plants, over three-quarters of which are for capacities of less than 50,000 lb per hr and for pressures of 250 psi or less.

General plant design: — Many of the designs this year hold to established practices. In some cases plants are designed on the skyscraper principle, in others on the bungalow or ranch house type. Choice depends on equipment design, available space, operating conditions, fuel storage and a dozen other factors, and neither one seems favored above the other.

Outdoor plants seem to be on the increase, especially in the Southern and Western parts of the country. More and more in the larger industries we see outdoor power plants. However there is still considerable debate about their relative advantages.

Trend towards more frequent use of cooling towers for condenser circulating water is evident, for these permit location of the plants, both utility and industrial, in places where water is either scarce or an uneconomical distance from the desired site.

Also there is considerable interest in using cooling ponds wherever this is possible instead of spray ponds or cooling towers. Notable case of this occurred at the Sandow plant, at Rockdale Works of Aluminum Company of America, June issue. There the production plant and its power plant are close to an abundant source of lignite fuel, and it was found feasible to establish a cooling pond in a depression nearby and fill it with water pumped from a stream 12 miles away.

More and more utility boilers are

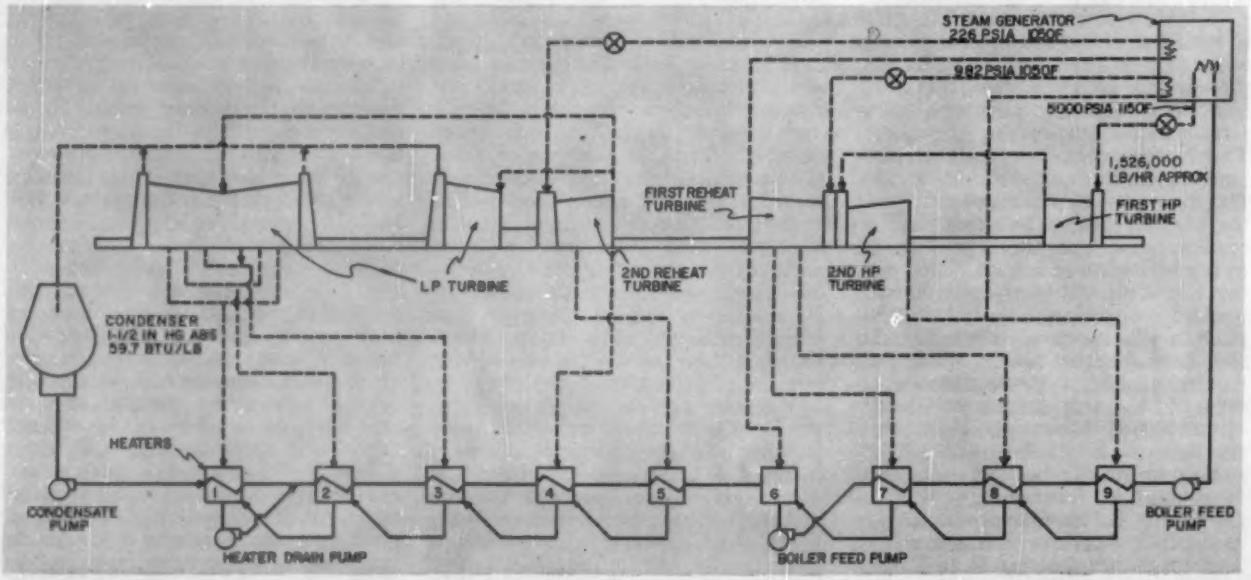


Fig. 1. Preliminary heat cycle diagram for Philadelphia Electric Co.'s proposed 275,000-kw, 5000 psi, 1150-F/1050 F/1050 F, 1.5-in. Hg (abs) turbine generator installation; uses a once-through monotube steam generator

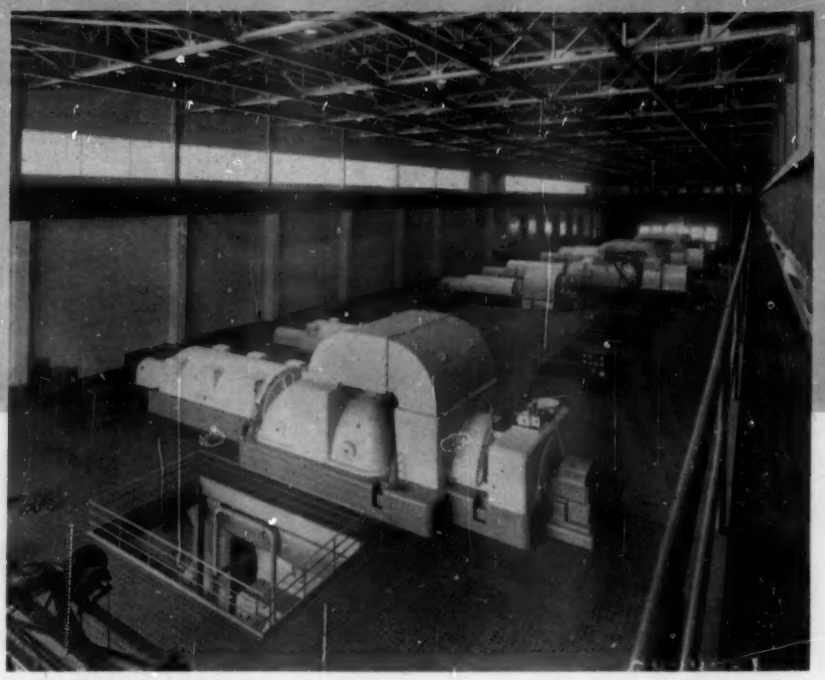


Fig. 2. View of the four turbine generators, capability 156,000 kw each (total 625,000 kw) installed in St. Clair Plant of The Detroit Edison Co.

being designed for pressurized furnace operation; and, although it is feasible to pressurize small industrial boilers, that trend has not yet become clearly marked.

In industrial power plants and boiler houses for process work, a good deal of modernization goes on, replacing a number of old obsolescent boilers with one or two modern units, and sometimes increasing turbine generator capacity. For plants able to generate by-product electricity from their process steam, the automatic extraction turbine is usually installed although some industries are using straight non-condensing and straight condensing units, as well as mixed-pressure units.

Other general practices that continue are use of controlled circulation steam generators, increased interest in demineralization for feed-water make-up, growing use of tractors and bulldozers for stockpiling and reclaiming coal in utilities and in many industrial plants, continuation of the reheat cycle in nearly all utility installations, greater centralization of power plant control and, of course, higher pressures and temperatures all around in the utility field.

Much attention is being given to ways of reducing power plant noise, especially from outdoor plants and large transformers. Good power plant and control room illumination are now considered a must.

Supercritical Pressure Plants: — Great interest in the two supercritical pressure power plants thus far announced has been evoked throughout the utility field, and in fact throughout the power engineering field generally, even though it will be some time before many power engineers will have a chance to operate such plants. Reason for designing plants for pressures up to 5,000 psi and temperatures up to 1200 F is principally that they promise to produce power at heat rates of approximately 8400 Btu per kwh as compared with 9,000 Btu per kwh for the best steam stations operating below the critical pressure. Many of the new installations now being designed and installed are for pressures of 1800 or 2,000 psi and there is one in existence for 2300 psi. To make an appreciable advance in thermal efficiency over these plants, it is necessary to take the big jump to the supercritical.

Another reason is that, for operation at or just below the critical pressure densities of water and steam become equal, as explained in the January 1954 issue, and this would introduce a number of operating difficulties because there would be no discernible water level in the boiler and separation of steam and water would be difficult.

Full details of the first of the supercritical units, the 120,000 kw unit for Philo Station, were announced in the July 1953 issue and explained more fully in the January 1954 issue.

The Philo unit will be fired with crushed coal by cyclone furnaces and the boiler itself will be longer and not so high as other types. It is designed to produce steam at 4500 psi and 1150 F with two stages of reheat at 1050 F and 1000 F. It will be of the once-through type, called a universal pressure unit, in which parallel tubes act like one long tube, and there is no steam drum. Gas recirculation will be used.

The Philo turbine generator will be a three-element 3600-rpm single-shaft machine with two reheat points and the necessary extraction feedwater heaters.

One of the problems in designing a supercritical pressure unit is that of designing the first stage blading to get proper stage efficiency, and this raises the minimum size of unit that is feasible.

Second supercritical unit details were given in the October 1954 issue. For preliminary heat cycle, see Fig. 1.

This proposed Philadelphia unit will use a monotube steam generator as developed and used in a number of installations in Europe. This, too, is a once-through, drumless, forced circulation type.

The turbine will be designed for 275,000 kw capability and 5,000 psi, 1200 F, although initial operation will probably be at 1150 F. There will be two reheat stages at 1050 F. Preliminary designs indicate that the furnace will be fired with pulverized coal by tangential tilting burners.

Initial designs are based on the use of a single-shaft tandem-compound turbine generator operating at 3600 rpm, but the designers are also analyzing the possibilities of using a cross-compound unit.

One important problem in the supercritical development is the boiler feed pump. These pumps will have to develop pressures of approximately 6,000 psi and to do that it maybe necessary to operate them at much higher speeds than with conventional units. This, of course, would be possible with turbine-driven pumps. For motor-driven pumps, it has even been suggested that motors operating at frequencies higher than 60 cycles might give the required speeds necessary to deliver the boiler water at desired pressure and quantity and at the same time reduce pump stages.

Instrumentation and control of the supercritical units present a number of problems. In the case of the monotube generator various controls used on subcritical units in Europe have been in operation for a good many years and these will be adapted to the Philadelphia unit.

Turbine Generators: — Work goes forward on the 260,000 kw units for one of the new Detroit Edison Co. stations. Units of 250,000 kw capacity are being planned for the Gallatin station of TVA.

A number of cross-compound units designed for capabilities of 150,000

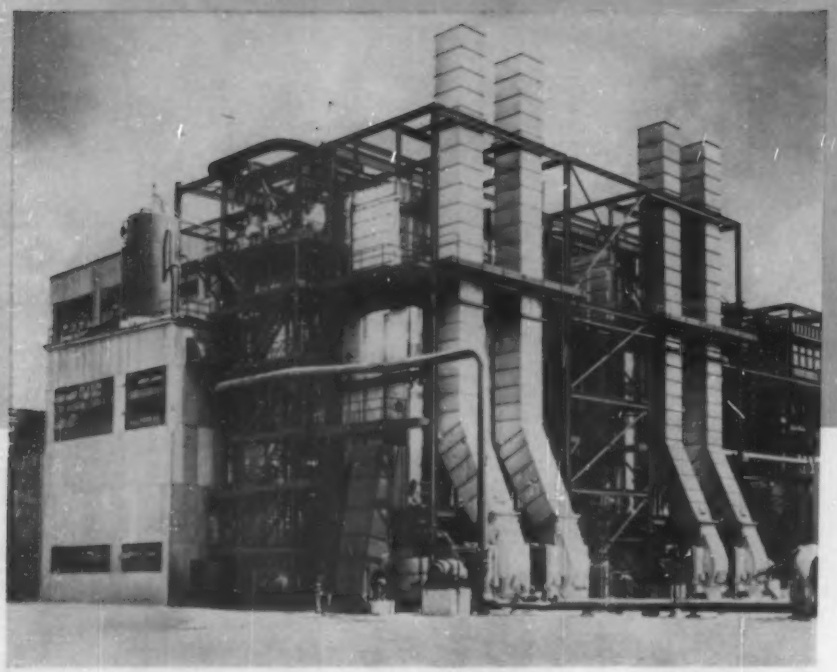


Fig. 3. Typical large industrial outdoor boiler plant. Two 450,000-lb-per-hr, 1425-psi, 950-F units, gas and oil fired, serving Dow's plant at Freeport

to 165,000 kw are being installed. Nearly half of the total capability of utility units being installed or contemplated are designed for pressures from 1800 psig to 2000 psig, with steam temperatures in most cases at 1050 F and 1100 F. In the larger units, reheat is almost always used.

Despite the increasing interest in demineralization for purifying feedwater outside the turbine cycle, evaporation for boiler feed make-up is still widely used.

In connection with the supercritical pressure turbine units discussed previously, one interesting suggestion is that the high-pressure section, to sustain temperatures as high as 1200 or 1250 F and pressures upward of 5000 psi, be designed as an expendable unit. That is, it would utilize available materials at stress levels that would result in relatively short life expectancy and would require careful study of the economics of the situation to justify it. Such a unit will be discussed in more detail in future issue.

Condensers: — In outdoor and indoor plants, more attention is being given to side-exhaust turbines and side-mounted condensers to reduce foundation heights. New forms of reverse flow condensers for various plants are being built. In one plant serving an aluminum works, all condenser and heat exchanger tubes are of aluminum.

In the field of circulating pumps, much more attention is being given, by means of model studies and proper design, to the intakes, particularly of vertical pumps, to insure proper pump suction and prevent cavitation.

Instruments and Controls: — Trend towards centralization of control continues, although a great many engineers feel that it should not be carried too far. Diagrammatic panels for control centers are on the increase. Industrial production engineers are beginning to hear much talk about "automation" but as one control manufacturer recently put it "What's new about that? We have had automation in power plants for years". There has been a continually increasing interest in multiple monitoring type instrumentation and control.

Good example in this field is provided by Sara, which keeps watch at three TVA steam plants, as described in February. Sara means sequential automatic recording annunciator. Using many electrical and electronic devices, it receives messages from approximately 400 alarm stations and oil circuit breakers throughout the three steam plants, memorizes rapidly-occurring trouble conditions or switching operations, and prints signals in proper sequence — all in seconds and fractions of seconds. Sara not only provides a permanent record of what has happened in the system, but saves much operating time and shows how trouble can be prevented in the future.

Another interesting development is continued use of the oxygen meter and recorder; in one particular case, tests are being made to connect such an oxygen recorder into a combustion control system, so that it will help to maintain best combustion conditions in the furnace. These tests will be reported later.

Fuels: — During the year an interesting development in processing lignite to produce a solid fuel, together with chemical by-products, came to fruition at the Rockdale Works of Alcoa, June issue. There a full-scale operation for drying and carbonizing lignite, developed by V. F. Parry, was constructed and is now in operation. Work is continuing to determine the chemical composition, uses and market for the by-products. A power plant of 240,000 kw capacity and three condensing type units was built to supply the aluminum works, and the fuel for this, at the time of the previous article, was dried lignite before carbonizing.

Another interesting operation is the burning of low-grade Iowa coal on spreader stokers by a utility plant in the middle West, details of which will be given in a future article.

Power Plant Auxiliaries: — Much attention is being given to details of design and construction of bearings and other parts of forced and induced draft fans for installation in outdoor power plants, as reviewed in the December issue. The canned pump, described in October, was originally developed for use in connection with atomic energy operations, but may find some very useful applications in future power plants.

Power plant communication systems continue to receive much attention, and require proper design and equipment, as reviewed in September. Applications of television in the power plant are increasing. Here the wired television system finds good uses in observing furnace conditions, water level, stack discharge, bringing pictures of these to screens in the central control room.

Winterizing: — More and more attention is being given to the subject of preparing equipment properly for winter, especially where winters are severe. Obviously, in outdoor plants, this must be done by making proper provisions in the design of the plant, but in many cases certain of the practices must be revised or improved after a period of winter operation.

Relatively new technique in power plants is the use of heating cable of special resistance type heating element in the form of insulated resistance wire. This offers controlled electric heat in such applications as pipe tracing and removal of ice and snow from structures and paved areas. It is used in tracing fire protection sprinkler headers and, of course, on outdoor pipelines. Regular steam tracing lines are often employed, especially on oil lines and various

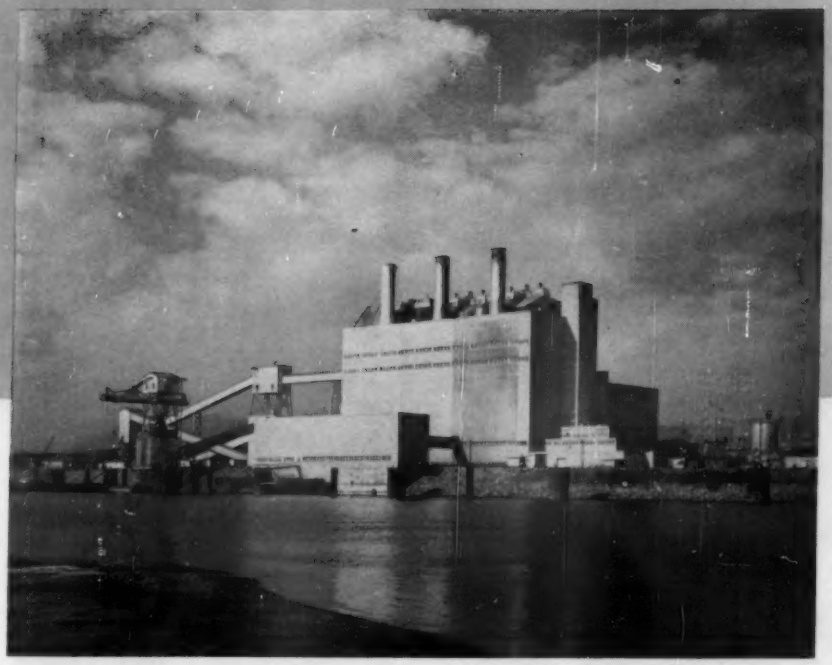


Fig. 4. Typical fully-housed utility plant is Elrama Power Station, Duquesne Light Co. Two 95,000-kw units and a third of 120,000 kw are installed

underground lines, and a new type of piping incorporating a separate compartment for tracing steam integral with the pipe itself has been developed. Preparing a diesel plant for the winter is an important and interesting operation, and this was detailed in our August issue. In one diesel plant, careful attention to the details of the engine cooling system, which is connected with the building heating system, saved about 40 per cent of the heating oil in a winter and made one-man operation of the plant much easier.

Air Pollution Abatement: — Power engineers are intimately concerned with the various programs going on all over the country for abating industrial smoke and dust emissions. They are co-operating most effectively with the various programs and using all the modern equipment available to solve the problem. New development in the electric precipitator field, that is improving precipitator operation, is the magnetic impulse wrapper, which shakes out the dust from the precipitator continuously and eliminates heavy puffs at infrequent intervals.

Utility companies are using the most approved techniques available for this work and so are most industrial plants. The solution always begins with best combustion in the furnaces, taken for granted in any good power plant, and in addition it may be necessary or desirable to use mechanical or electrical precipitators or combinations of both, as in many plants.

Fig. 5. Here is the steam drum being shipped for one of new 1,700,000-lb-per-hr, 2000-psi boilers at Detroit Edison's new River Rouge plant. Drum is 82 ft long, has wall thickness 6 in.

Materials: — Many new construction and equipment materials are being developed to decrease costs of operation and maintenance in the power plant, and power engineers are using these to the fullest advantage. In power plant buildings, pre-cast insulated wall panels, or insulated aluminum or steel panels, are frequently replacing brickwork and are producing power plants of very attractive appearance.

New insulation materials for piping and equipment are constantly being developed, also many new types of paint and coatings for structures and equipment above ground and for piping laid underground. A well known utility company has used a 3-in. plastic pipeline, ¼ mile long, for delivering well water to its plant, shown in the March issue. Plastic instrument tubing is also being applied.

Power engineers are also trying out various uses of ceramics in power equipment. The October issue reported tests on ceramic-coated tubes used in an air preheater in an actual operating boiler in comparison with plain steel tubes.

In another industrial power plant a steel stack for a new boiler is coated inside with a ceramic coating to prevent corrosion.

Lubrication: — Proper lubrication of all power equipment is obviously a must in every power plant. In utility plants turbine lubrication is very carefully engineered by co-operation between designers, operators and oil suppliers.

Splendid example of a good industrial lubrication program for an industrial plant, and one that should be studied carefully by all industrial power engineers, was detailed in the November issue. This program of Eastman Kodak Co. reduces number of lubricants stocked, gets the right man for each job and prevents unscheduled outages of power equipment and allied services.

Anniversaries, Hurricanes, Floods: As already noted, on previous pages, this year marked the 75th anniversary of the development of the first commercial incandescent light by Thomas A. Edison and the founding of the power industry, which has developed into the tremendous giant we are describing here.

During the past year, nature produced some problems for power engineers that taxed their power systems severely.

In the Eastern part of the country, Hurricanes Edna and Hazel wreaked severe damage but the power utility personnel performed magnificently and restored service where it had been interrupted in a very short time.

A freak flood caused by an unexpected heavy rainfall for two days in the Chicago area severely handicapped the operations of the utilities there, knocking out approximately 800,000 kw of their capacity through flooding of power stations. Here again this capacity was restored to service within a few days.

Stream Pollution: — The power field as a whole is becoming acutely conscious of the relation of all its activities to the problems of industrial water, waste disposal and stream pollution. Of growing importance is the effect of stream pollution abatement on the electric loads of utilities and industries. For sewage treatment for 60,000,000 people, one engineer estimates electric load of 3,960,000 kwh per day.

Hydro, Diesels, Gas Turbines Share Upward Trends

Fig. 1. Flatiron Power and Pumping Plant in Colorado. Big Thomson project near Denver, contains first U. S. reversible pump-turbine; rated 13,000 hp as pump, 12,000 hp as turbine

HYDROELECTRIC power is still an important factor in the overall power picture of the United States, although the proportion of hydro generated power and capacity is gradually decreasing as more and more steam electric plants are built. In 1953 approximately 1,500,000 kw of hydroelectric capacity was installed, raising the total to about 25,000,000 kw, and this produces approximately 25 per cent of the total output. In technical developments during 1954, there have been outstanding plants and hydroelectric units in very large sizes as well as much interest in development of very small water powers.

In the great Kitimat-Kemano development in British Columbia, three of the proposed sixteen 150,000 hp vertical-shaft impulse turbines, described in our June issue, have been placed in operation in the underground power house, and the development has many other unusual features, such as transmission cable of oil-filled aluminum construction.

Although the largest part of hydro development is being built by various agencies of the Federal government, still the political changes in recent years are stimulating utilities and private industries to take a larger and larger share.

Many of the largest hydro developments throughout the country are already under way, therefore attention is now turning to smaller ones. Many industrial and small utility hydro plants can be modernized and considerable activity is under way in working out designs for these.

First single-unit, reversible pump-turbine in the United States, was put in service as told in the September issue. This unit, installed at the Flatiron Power and Pumping Plant near Denver, Colo., operates as a pump to deliver 370 cfs to a storage reservoir in a big irrigation system and then, using the same water, drives the unit in the reverse direction to generate up to 8500 kw of electric power as the water flows to irrigation. A second reversible pump-turbine is now being installed in the Hiwasee Plant of TVA, as detailed elsewhere in this issue and other larger units are being considered for the proposed Niagara Falls power development, status of which is still undecided.

Diesels: — Many diesel engine generating units are being installed, not only in private and municipal utility plants, but also in industries. These usually range in size from small units for direct drive up to units of around 1200 to 1500 kw for generator drive. Most of the new ones are of the dual-fuel type.

In most cases, standard diesels can be obtained fairly quickly to meet fast rising power demands, and they have proved valuable when added to steam plants, as described in our October issue, both for rapid expansion and for good load balancing.

In that case, a municipal system installed dual-fuel engine generators first, pending completion of a new coal-burning steam electric plant. Now the steam plant is in operation and the coordinated steam-diesel team is simpler in operation, no additional manpower was needed, and in one year of operation, the combination has saved $4312 in fuel cost. The complete plant is shown in Fig 3.

Another interesting combination of steam, diesel, and hydro plants all located close together and operating as a coordinated system, was described in May.

Gas Turbines: — Proponents of the gas turbine have always maintained that it was not necessarily going to replace but on the contrary was going to supplement our other prime movers. In its most effective range of capacity, up to about 5,000 kw, this has proved to be the case, but in some instances it may prove ready to do battle with other forms of power. Well over 100 gas turbines have now been sold or installed for various utility and industrial uses.

The gas turbine field has been given considerable impetus by the success of one utility in operating stationary gas turbine electric generating units on Bunker C fuel oil, properly treated to prevent the corrosion that has been caused by this oil in gas turbines. This follows, of course, the successful use of properly conditioned Bunker C oil in 10 gas-turbine-driven locomotives on a Western railroad.

Essentials of the treatment process for residual oils being used by one utility company are centrifuging and washing with water, or a water solution of a suitable salt and addition of a water solution of magnesium sulfate to the fuel just before it is burned. Details are given in ASME paper No. 54-A-246. This method differs in some details from the centrifuging and washing technique used for some

Fig. 2. Workman locking compressor blades individually into compressor wheel disk for a gas turbine to be used for a gas pipeline pumping station

Fig. 3. View in a recent municipal power plant where two 1250-kw dual-fuel engine generators team up with two 5000-kw steam turbine generators to supply reliable power and cut fuel costs, with no added manpower

time at the famous Tacubaya plant.

As described in November, two 3900-kw simple-cycle dual-fuel gas-turbine-driven generating units have just been installed in an existing steam plant, with possibility of big savings in maintenance and operating costs and reduction in operating manpower. Another important feature here is the care taken to quiet the installation, which is near a residential district, by use of proper exhaust mufflers. Nearby residents cannot always determine from the sound that the gas turbine units are in service.

Use of gas turbines in connection with steam turbines, in another case, has increased the steam equipment's efficiency by more than 13 per cent.

One manufacturer has shown a model of a 15,000-kw gas turbine generating unit for stationary power installation. This is a two-shaft machine in which the low-pressure turbine drives a low-pressure compressor while the high-pressure turbine drives high-pressure compressor and generator. The set has both regenerators and intercoolers.

Much interest has been aroused by the development of small gas turbine units, because of their possibilities in automotive drives, and for small mechanical drive applications in industry as well as for generator drives.

One of these units, developed by one of the aircraft manufacturing companies, was shown on page 77, August issue. This small unit also has separate compressor and power turbines, and a rated output of 240 to 270 hp.

At the recent 21st National Power Show, besides the model of the 15,000-kw gas turbine set noted above, and a 5000-kw set, a small gas turbine rated at 50 hp was also displayed. This small unit, too, was a product of one of the aircraft manufacturing companies.

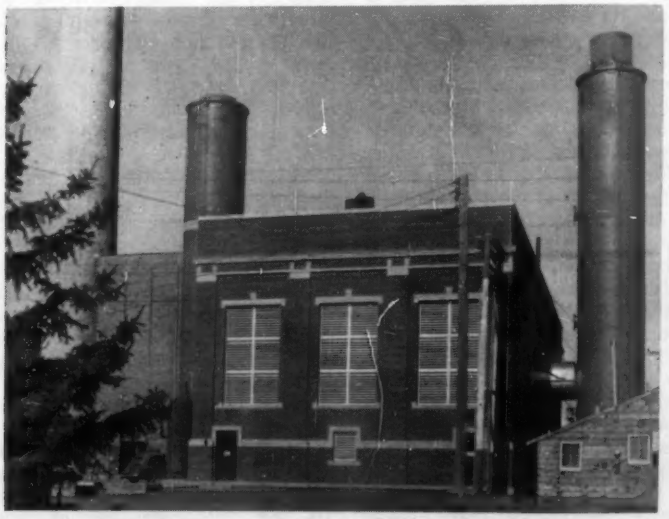


Fig. 4. This building houses an existing 2000-kw steam turbine plant to which has just been added two new 3900-kw simple-cycle gas turbine generators designed for burning either gas or oil

Another outstanding development in the gas turbine field was the description in an annual ASME meeting paper of a gas turbine locomotive, known as the Polar Bear, developed for the U. S. Army. This locomotive is powered by two 500-hp oil-burning gas turbines, their power being delivered by mechanical transmission to the driving wheels. The locomotive is designed for use in cold climates, for elimination of water uses, for quick starting and quiet operation.

Coal-Fired Gas Turbine: — On the 4250-hp pulverized-coal-burning gas turbine now under development by Locomotive Development Committee, over 1000 hours of test experience have been accumulated with direct coal firing.

Following a 300-hr test run of this unit, ending September 14, 1954, the committee reports, in ASME paper No. 54-A-201, that solutions have been found to the three major problems on which it has been working:

1 — Feeding coal of suitable size to a pressurized film-cooled combustor.

2 — Burning the coal with more than 90% combustion efficiency.

3 — Separation of ash from the heated air to the extent necessary for preservation of turbine blade erosion.

It is now reported that, at the end of the above 300-hr test, using the latest model of ash separators developed by the committee's staff, there was no erosion of any consequence on the gas turbine blades.

The regenerator on the unit had been removed but it has been put back again, the unit is being reassembled and will now be run again as long as possible.

Electric Circuits —

While the design and construction of larger and larger electric generators, and the ever-growing extent of our electrical systems continue to mark the progress of the industry, many remarkable developments are taking place in small devices—in rectifiers, transistors, magnetic amplifiers, and circuits using these devices.

ONE of the highlights of the year's development in the electrical art was the establishment, in October, of the 100 million kilowatt level in the nation's central station generating capacity. This compares with a level of 50 million kilowatts less than ten years ago. As a consequence of this ever increasing capacity of our electrical systems it becomes practicable and necessary to use larger and larger generating units and at the present time machines of 275,000 and 300,000 kw are on order. The design of electric generators of such large capacities involves not only the use of higher voltages but also new and more effective methods of cooling.

Modern electric generators are remarkably efficient machines but even the few per cent losses in a 275,000 kw unit add up to five or six thousand kilowatts of heat, and this heat has to be removed if the temperature of the machine is to be kept within reasonable limits. All of the very large machines now employ some method of *super* cooling, using hydrogen gas and in some instances liquid cooling is being considered. With liquid cooling of generator, some 15 times as much can be removed from the copper as with conventional hydrogen cooling. An important factor in the design of large generators and transformers in reducing the heat losses has been the use of grain-oriented steel in the magnetic circuits.

One of the problems in the design of generator cooling systems has been the avoidance of hot spots, that is, high local temperatures at certain points in the interior of the machine due to unequal heat transmission. To overcome this difficulty one manufacturer has developed a design in which cooling gas is forced into, through, and out of the windings at several points along the entire length of the rotor. As a result, temperature distribution is far more uniform than it would be if this was not done. This method involves the use of scoop devices flush with the rotor surface, to pick up cool gas from the air gap between rotor and stator. The impact head from the scoops is used to create a strong flow of gas into each winding slot through the forward-slanting holes in the wedges and teeth, then axially through passages inside the turns of the windings and finally out to the air gap again through backward slanting discharge holes.

Exploitation of direct cooling in generator fields is making possible the building of much larger machines than were possible previously in single generators within the space and weight limitations already established for conventional designs, as well as a considerable reduction in dimensions and weight for ratings previously achieved. The advance in field output is so great, that a corresponding advance in stator output is required also. This can be done in a variety of ways: by new arrangements of the armature windings, by direct gas cooling of the armature, or by liquid cooling, as is being done in one 260,000-kva 3600 rpm generator now under construction.

25,000,000 Kva Circuit Breakers

One of the consequences of the great increase in the size of individual generating units as well as the growth in the size of the electric systems to which they are connected, is the need for switchgear of higher and higher interrupting capacity. The concentrations of energy are becoming so great that switchgear designers are having to work closer and closer to the practicable limit of their methods and materials. At the present time we are building circuit breakers with ratings of 25 million kva interrupting capacity at 330 kv. These will serve for the present but they will be inadequate for the concentrations of energy that may exist ten years from now. New basic concepts of circuit interruption are needed.

The achievement of the 25 million kva, 330 kv circuit breaker just mentioned is remarkable when it is considered that only five years ago, a breaker with an interrupting capacity of 10 million kva at 230 kv was thought to be close to the "ceiling." Now, with the heavy loads being projected for the 330 kv lines of this country, particularly the tremendous concentration of electric power at the new Atomic Energy Commission plant near Portsmouth, Ohio, have brought the demand for 330 kv breakers with 2000 amp continuous current capacity and the unprecedented interrupting capacity of 25 million kva. Contrary to the usual expectation of low continuous current-carrying ratings for ultra high-voltage breakers, these breakers at times may be required to carry load currents approaching 2000 amp, representing one million kilowatts on a single transmission line. Special attention to the contact details was required to provide the requisite thermal capacity and still keep them light enough to travel at the speed necessary for 3-cycle interrupting time. The heart of this high capacity breaker is the interrupting device which makes possible quenching of the arc drawn by the separating contacts in a minimum time and with a minimum of disturbance. The details of this interrupter assembly are shown in Fig. 1. It represents a radically new design with four independent arc-rupturing units assembled in an insulating tube for simultaneous operation. A spring-driven oil pump at the top of the assembly as indicated in the sectional drawing provides the oil flow to each break for the interruption of line-charging currents without arc restriking. A special feature is the removable laminated and cemented fiber block which guides the oil flow in the arcing region of each contact gap and provides the exhaust vent channels. Sufficient oil storage is provided close to the arc to produce self-generated deionizing action for high-current interruption.

It was, of course, impossible to demonstrate a 3-phase interrupting capacity of 25,000,000 kva in any high-power laboratory available at present. However, the unit test method whereby a subdivision of the breaker is tested to full rated current-interrupting capacity at its proportionate fraction of rated voltage is recognized as a reasonable approach to the demonstration of the arc-rupturing ability of the breaker, and this method of testing was used in the case of these breakers.

Old and New

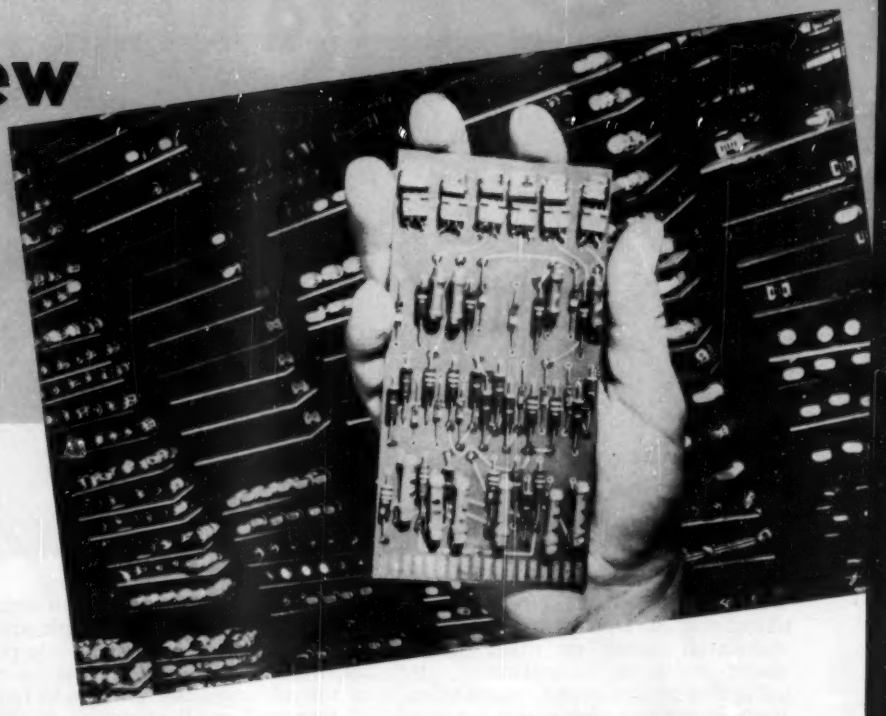


Fig. 2. These printed circuit panels with their diodes, resistors and transistors are making possible completely new concepts in electrical circuitry. This is part of the equipment used in IBM's new experimental transistor computer

Transmission voltages in the United States so far have not gone above the 330 kv established for the American Gas & Electric Co. system but in Europe transmission voltages as high as 400 kv are in use. In Sweden, for example, 400 kv is used on some long transmission lines. When the American Gas & Electric Co. was making its studies on higher transmission voltages, one of the reasons it gave for not going above 330 kv was radio interference. That this was an important consideration is now indicated by the fact that the 230 to 400 kv lines in Sweden have caused serious interference for radio listeners living in the vicinity of these power lines, particularly in the northern part of the country where the radio field strengths of the broadcast transmitters are low.

Curiously enough, this trouble resulted in a solution that is somewhat unique but it has yielded successful results. This solution is based upon the transmission of the radio program directly over the interfering line itself. The principle followed consists in the connection of a radio transmitter to the power line through a capacitor located in a suitable position in the line system. The transmitter output is so adjusted that the signal level for the radio program exceeds the interference level from the power line by such an amount that the interference is no longer perceptible. Reception can take place in the usual manner by tuning the receiver to the frequency of the power-line transmitter with no special adjusting.

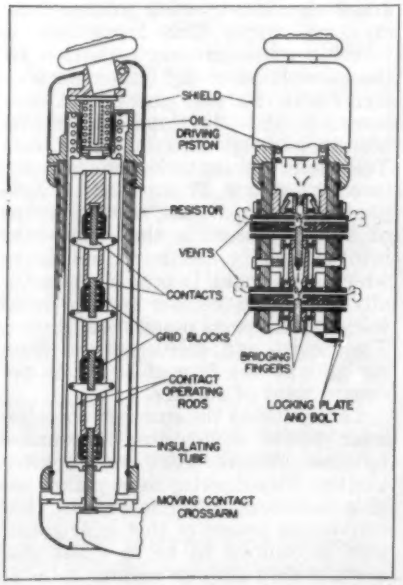


Fig. 1. Sectional view of the 4-break interrupter assembly for the 25,000,000 kva, 330 kv circuit breaker. This shows the oil driving piston, flow-guiding fiber grid blocks, moving contacts, etc.

Transmission Details

The development of the A G & E 330 kv system has resulted in an enormous advance in the design of equipment for transmission systems. Its effect on circuit breaker design has already been indicated. The 25 million kva breakers described above are the direct result of this development. Similar advances had to be made in the design of disconnect switches. Initially, the design of a substation involving breakers 27 ft high, disconnect switches 26 ft high over the open blade, and similar sized equipment required both courage and sound engineering. The design finally chosen was based on a design which had been in successful use for years at 132 kv. In the design of such disconnects, the corona and radio interference shielding problem is extremely important and hundreds of tests were necessary in the study of these two factors. The 3-pole disconnecting switches finally developed had to meet all of the following requirements: freedom from corona, ease of operation, suitable blade control, adequate ice-breaking mechanism, and suitable contact and blade design for carrying safely the rated continuous current of 1600 amp as well as short circuit currents corresponding to a fault of 25,000 kva.

The major problem in connection with the design of the power transformers for 330 kv operation was the determination and development of satisfactory insulation strength. The large blocks of power to be handled made the factor of size and weight of serious concern, particularly in connection with shipping and installation limitations. The 78,000 kva 17/330-kv single phase units are forced-air forced-oil cooled with the power source for driving the fans and pumps an integral part of each transformer. In the case of the 300,000 kva transformer banks which tie 132 and 330 kv systems together at the various stations, it was decided to use two 3-phase, 150,000 kva autotransformers in a bank.

The 330 kv American Gas & Electric system has been considered in some detail here because, as already mentioned, this system influenced the design of nearly all of the equipment connected to it, and since this is the highest voltage system in operation in this country, the equipment naturally has outstanding characteristics.

Among the large self cooled transformers built during the year was the unit for the Jersey Central high-voltage transmission system at the Raritan River Station at Sayerville. This unit's self-cooled rating is 84,000 kva, but this can be increased to 140,000 kva by putting its 46 high velocity cooling fans into operation. This is one of the largest transformers ever built.

In connection with transformer operation, one of the interesting developments of the year was a development to come out of G-E's new sound laboratory at Pittsfield, Mass.

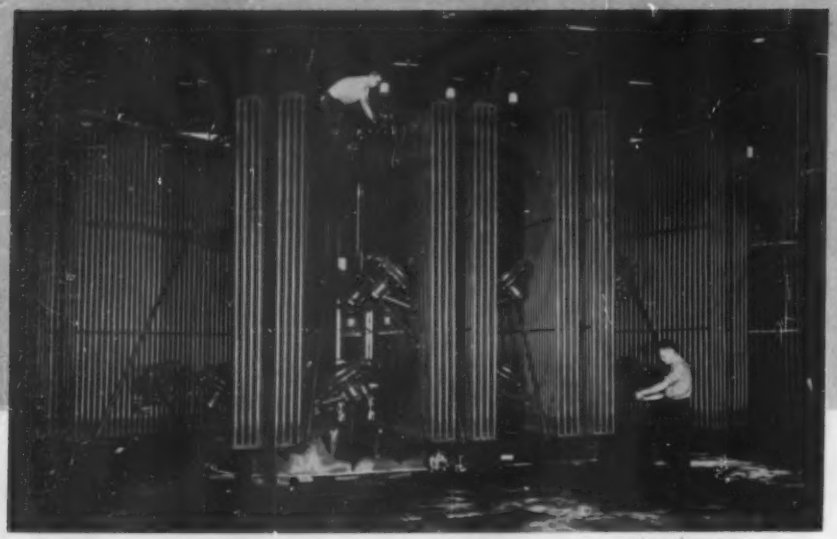


Fig. 3. Typical of the large transformer developments during the year was this huge 84,000 kva self-cooled transformer built by G-E for Jersey Central's Raritan River Station at Sayerville. The rating of this unit can be increased to 140,000 kva by putting all of its 46 high velocity cooling fans in operation

This has to do with the reduction of objectionable transformer noise in residential areas or other places where noise is objectionable, by using the idea of sound cancellation. By this method the sound levels of transformers have been reduced as much as 15 decibels at distances of 25 to 75 feet and greater. Sound cancellation is basically very simple. Sound waves from any transformer have certain characteristic amplitude and frequency composition. By sending out another sound beam with identical characteristics, *but opposite in phase*, the sound waves cancel out, leaving a cone of silence. In applying this principle, a loudspeaker is mounted on the transformer tank and beamed in the direction of an apartment house or dwelling. By adjusting the volume and phase of the speaker, sound levels have been reduced as much as 1/32nd of their former value.

An interesting development was the entry of General Motors Co. into the electric generating field with the announcement of the Electro-Mobile power units. These are completely self-contained mobile (or portable) power plants consisting of diesel-electric sets mounted on skids, highway trailers or railroad cars. Three units (500, 750, or 1000-kw) are designed for movement over railroads and may be located on any convenient siding near transmission lines to be served. Two units (350 or 500 kw) are designed for movement over highways. Four models of the portable plant, consisting of the same major components as the mobile units, are available in 350, 500, 750, and 1000-kw assemblies mounted on skids for permanent or semi-permanent duty.

Transistors, Magnetic Amplifiers

Electrical development extends from the almost infinitely small to the very large. We have discussed some of the very large developments — large generators, transformers, systems extending thousands of miles across the country. Although spectacular, these developments are perhaps no more important than some of the advances being made in some of the very small electrical devices, in transistors, in light-sensitive cells, and, of course, in basic research in electronics.

At the present time, transistors are available only in watt sizes but research engineers are doing things with them now, in conjunction with magnetic amplifiers, that are difficult for electronic engineers to believe. Many of these come from a fairly recent concept, the concept that while the transistor alone is remarkable and is (with the magnetic amplifier) the key to it all, the things achieved by the new circuitry it makes possible are fantastic, particularly as larger capacity crystals become available. At the Westinghouse Research Laboratory, transistors, in proper circuits, are being used as switches or relays. They make possible switches, completely static and with indefinite life, having an efficiency of 90 per cent compared to the 50 per cent of a class-A amplifier. A combination of transistors and magnetic amplifiers can be used to create a time delay of any given length. And always, the accuracy is to one cycle of the basic frequency used. For example, a delay, even of days or weeks, could be provided accurate to 1/60 of a second, if a 60-cycle power supply is used. This same circuit can be used as a counter of events, as represented by pulses. The old dream of a high-efficiency direct-current transformer becomes a reality. Transistors, in a relatively simple circuit, can convert direct current to a square wave. This, being alternating, can be changed in voltage, and, by full-wave rectification, returned to direct current. Overall efficiencies for circuits delivering a few watts are about 90 per cent.

Closely related to transistor development is the work being done in the development of metallic rectifiers by the use of germanium. Much of the transistor development, of course, is being done with germanium. Some of the new germanium rectifiers have remarkably high capacities with respect to their size. A recent 2000-watt germanium rectifier can be held in the palm of one's hand. The rectifying element itself is a wafer of germanium, the size of a dime. The complete unit, including cooling fins and mounting brackets, weighs 12 oz.

These developments are all results of our greater knowledge of solid state physics. Until recent years most of our knowledge of the behavior of electrons concerned matter either in the gaseous or the liquid state. Very little was known concerning the behavior of electrons in solids. The basic researches at the Bell Telephone Laboratories giving rise to the birth of the transistor, and the tremendous work done in the field of nuclear physics as a result of the development of the atomic bomb, gave us a deeper insight into the structure of solids, and the gradual accumulation of knowledge is beginning to bear fruit in many ways. This knowledge is focusing much greater attention on the conversion of light into electricity. Early in the year RCA announced the development of its atomic battery, and in April, Bell Telephone Laboratories brought out its solar battery. This amazingly simple-looking apparatus, made of strips of silicon, converts the sun's rays into electricity, with an efficiency which may make it possible to actually use it on certain remote rural telephone lines as a source of power. The device can deliver power from sunlight at the rate of 50 watts per square yard of surface.

Later, during the summer, a similar solar power device was announced by the Wright Air Development Center. This development makes use of a cadmium sulphide crystal. The conversion power of this solar generator is claimed to be so great that a wafer-thin slab or crystal 4 by 15 ft on the roof of a house, will supply enough current to operate all its lights, range, refrigerator, and other appliances, 24 hours a day. We do not know whether these claims have been substantiated.

Two-Stroke Gas Engine Gets Second Wind

By C. A. CHAMBERLAIN
and G. H. BOLLMAN*

TWO-STROKE gas engines are inherently simple to operate, reliable and efficient. If this is the starting point, what could be gained by adding turbosupercharging — giving them a "second wind"?

In a paper presented before the ASME recently, the authors posed this question, but they answered it as well. A natural gas engine designed and built by Clark Brothers translated their answers into performance. Figure 1 summarizes some of the engine's characteristics as a function of load.

For a given engine, the addition of turbocharging raises the indicated horsepower only 16 per cent while raising the output (bhp) some 33 per cent. This results in an increase in mechanical stresses but the increase is considerably less than the increase in output. Efficiency, too, is improved by turbocharging as shown by the following heat balance data:

Unturbocharged cylinder (in terms of ascribed horsepower): output, 250 hp; scavenging, 30 hp; auxiliaries, 4 hp; radiation, 8 hp; water- and oil-cooling, 216 hp; exhaust gas, 278 hp. **Turbocharged cylinder:** output, 333 hp; auxiliaries, 4 hp; radiation, 8 hp; cooling, 205 hp; exhaust, 366 hp. Expressing these factors differently, the common cylinder requires 8000 Btu per bhp hr, while the turbocharged version of the same cylinder requires only 7000 Btu per bhp hr. This common cylinder, then, would have an overall efficiency of 31.8 per cent and the turbocharged cylinder would have 36.4 per cent efficiency.

Another factor recommending turbocharging is the internal cooling accomplished by the increased flow of engine air. All internal parts of the cylinder, therefore, would operate at a lower mean temperature and lower thermal loading.

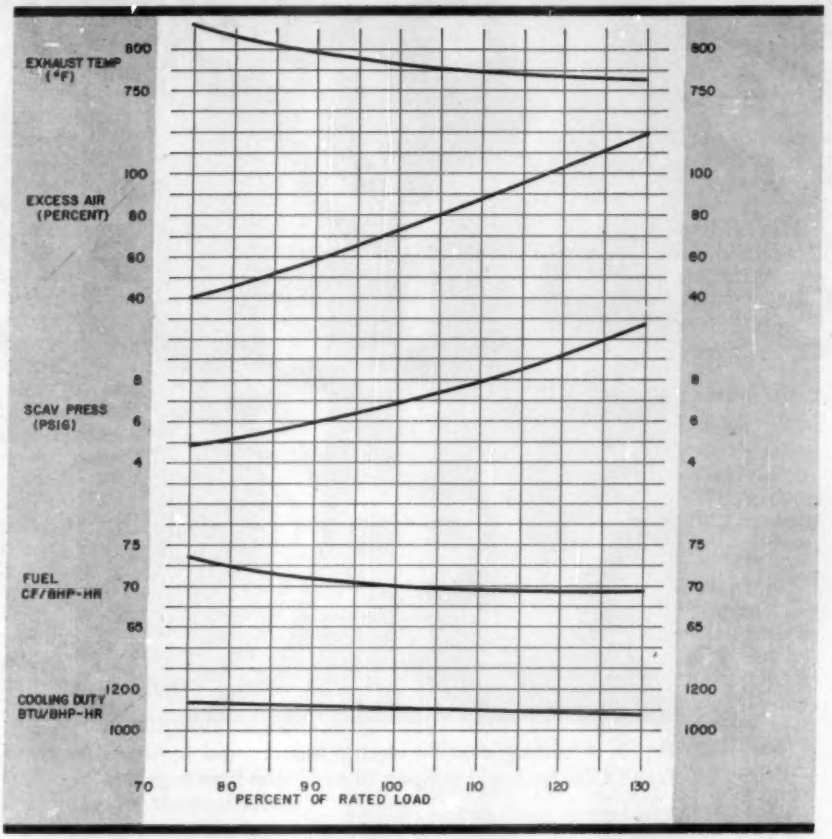
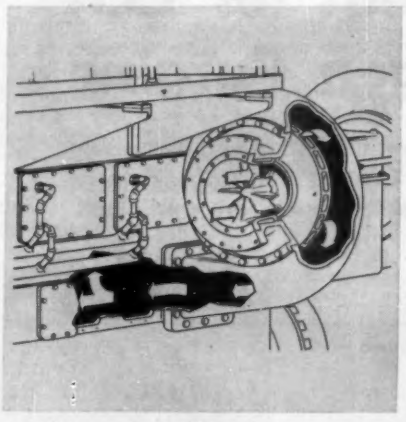
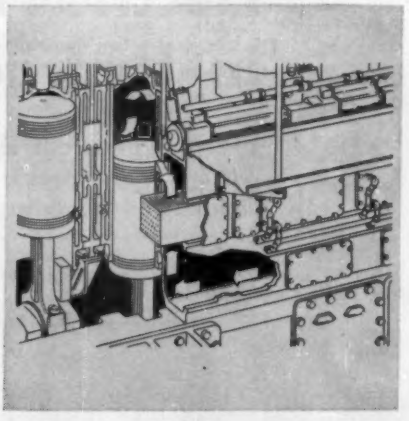


Fig. 1. Curves relating performance characteristics to per cent of rated load



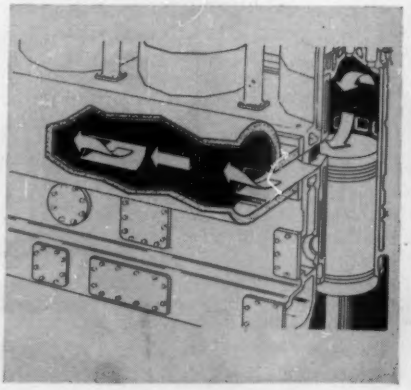
Upper Left:

Fig. 2. Supercharger compresses outside air, feeding it to a distribution duct



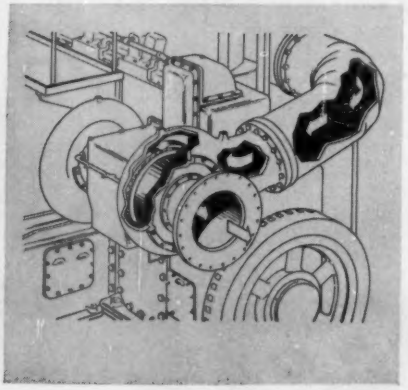
Upper Right:

Fig. 3. Scavenge air enters cylinder via intercooler (also acts as flame arrester)



Lower Left:

Fig. 4. Exhaust gases and some scavenge air are collected in a single manifold



Lower Right:

Fig. 5. Exhaust is ducted to turbine at about 785 F and 4 psig to power blower

*Clark Brothers Company, Olean, N. Y.

Fig. 1. A carbon dioxide electric heater used to vaporize liquid CO_2 for rapid purging of hydrogen from a generator

Electric Heat for CO_2 in Hydrogen Purging

To reduce generator downtime, speed up hydrogen purging with electric CO_2 heater, says author. Details and advantages of system are explained

By ROY E. McILRATH

PURGING HYDROGEN from generator housings with carbon dioxide gas is usually a time-consuming, and consequently costly, operation. With the CO_2 purging techniques often practiced, up to seven hours is required to drive out the hydrogen, and another hour to purge the carbon dioxide with air. After repairs have been made, the reverse of this process consumes an additional eight hours; thus some 16 hours are lost in carrying out a necessary but essentially unproductive operation. This lost time seriously reduces the 57 hours usually available for repairs on a scheduled downtime between 10:00 P.M. Friday and 7:00 A.M. Monday. Even repairs which must be made during the week under emergency conditions are delayed the same 16 hours for purging and replacement of hydrogen.

Where time is a critical consideration, purging hydrogen from a generator system should not take more than one hour at the stage when carbon dioxide is introduced into the system. The purging system outlined in this article can reduce normal purging and replacement time from the usual 16 hours or more to approximately 4 hours, a saving of 12 hours generator downtime as well as a substantial saving in labor man-hours. Further, more hours can be available for inspection and repair.

Problems of Handling CO_2

The problems of purging with CO_2 are inherent in the physical properties of the gas itself. Each 50-lb cylinder of CO_2 contains approximately 45 lb of liquid CO_2 and 5 lb of CO_2 gas at 853 psi at 70 F. As gas is removed, the pressure in the cylinder is re-reduced, which causes some of the liquid to change to gas; the remaining liquid gradually warms up until the equilibrium point is reached and the pressure is restored to 853 psi at 70 F. Therefore, as long as there is

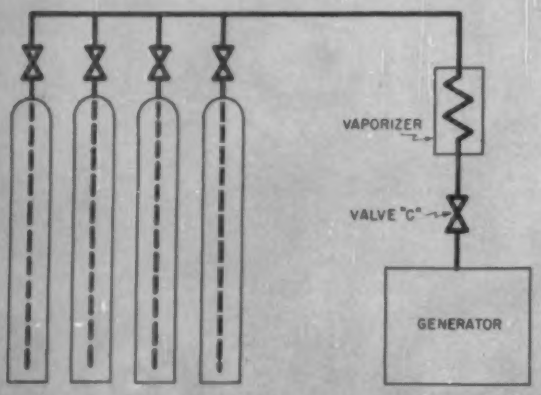


Fig. 2. System utilizing upright CO_2 cylinders. Siphon tubes reach bottom

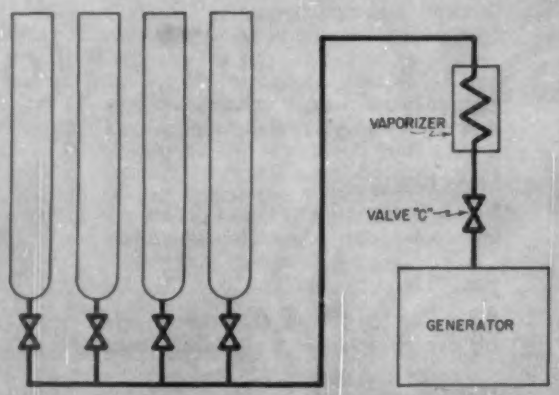


Fig. 3. CO_2 cylinders "upside down" in this set-up. Siphon tubes not required

any liquid CO_2 left in the cylinder, the pressure is not a measure of the amount of CO_2 in the cylinder but rather the pressure is an indication of the *temperature* of the liquid in the cylinder.

Carry this on one step further: if a full 50-lb cylinder is opened to atmosphere, in a matter of one or two minutes there would be no pressure left in the cylinder. However, the cylinder would *not* be empty, but would have about 25 lb of CO_2 in the form of dry ice; if the cylinder were left open, this dry ice would gradually warm up and escape as gas in approximately 12 hours.

Boiler Analogy

If you had a small upright boiler with 100 psi of steam pressure, it would be a simple matter to remove all of the steam by opening a valve in the top of the boiler. But, the only way you could get all of the water out the top of the boiler through that valve would be by applying enough heat to convert the water into steam. Only then would it pass through the valve in the top of the boiler.

A cylinder of carbon dioxide presents much the same problem as the boiler. When you open the standard $\frac{1}{8}$-in. cylinder valve orifice, you get a lot of action for a little while. Much of the contents, however, will remain in the cylinder until room temperature — or other sources of heat — warm up the CO_2 remaining and convert it into vapor. Assuming room temperature of 70 F as the only source of heat, a 50-lb container of carbon dioxide, standing upright and discharging from a valve at the top, will deliver 4 lb of CO_2 an hour, and either by sudden exhaust of *part* of the contents or by a steady flow of the gas, it will take approximately 12 hours to empty itself completely.

In a purging system for hydrogen-cooled electric generators or for similar industrial uses, the use of carbon dioxide is intermittent, and frequently of a semi-emergency nature. A delay of 12 hours or so for the cylinders to empty at room temperatures is not practical. Further, where the gas is suddenly discharged, the extreme temperature drop causes a reduction of volume which further interferes with the attainment of the desired ends.

Continuing with the steam boiler example, there is a simple way of getting all the water out quickly, and that is by opening a valve at the bottom of the boiler and using the contained steam pressure to push the water out. The same thing can be done by using an internal tube with an inlet just above the bottom of the boiler, and an outlet located at the top of the boiler, or elsewhere, as may be convenient. The rapidity of exhaust is controlled simply by the size of the valve opening.

Now, if you take a cylinder of carbon dioxide and turn it upside down, or use a cylinder with a tube extending from the valve to the bottom of the cylinder, the same sort of thing happens. The gas pressure in the top of the container will push the liquid out of the bottom, and in a matter of three minutes or so the container will be empty — just as rapidly as the opening of the valve will allow. The same is true of a dry ice converter with either a valve in the bottom or a valve connected to a tube with its end in the bottom of the converter.

Snow Undesirable

With carbon dioxide, however, the difficulty is that when the liquid is thus forced out into the air, much of it immediately becomes "snow," which in its turn must slowly warm up and change to gas in order to perform the purging function. Messrs. Snell and Schmid, in a comprehensive article published in POWER ENGINEERING in February, 1950, stated: "In method 'E', liquid CO_2 from the containers is converted into 'snow' or vapor at hand-valve 'V' and is discharged in this form into the machine casing. This method has been used, but since it may produce harmful stresses in the casing parts through extreme reductions in temperature, its use cannot be recommended." In addition, this cold gas and 'snow' does not have the required volume for purging systems.

The first step in designing an efficient and rapid-acting purging system, then, is to select as a source of CO_2 either cylinders placed with the valve down, cylinders with a siphon tube from the outlet valve to the bottom of the cylinder, or dry ice converters with the outlet valve connected to the bottom of the converter. In any of these ways you make available any amount of liquid carbon dioxide necessary, with delivery rate regulated simply by the aperture of the valve used.

The second step is to heat the liquid to the necessary temperature in order to vaporize it and also to compensate for the drop in pressure from 853 psi to atmospheric pressure. When this is done, the CO_2 is immediately converted into its gaseous state on passing from the vaporizer to the housing chamber.

Various methods involving the use of steam heat and hot water baths for the cylinders and CO_2 lines have been used. The disadvantages of these methods are two: (1) the heating method does not provide a constant, readily controlled, even heating of the cylinders or lines, and (2) the extremely low temperatures involved in the liquifying and/or sublimation of carbon dioxide create an ever-present danger of freezing traps, valves, tubing, and other equipment in the system.

New Heater Described

Ebasco Services have recently installed one of the first thermostatically-controlled automatic electric carbon dioxide vaporizers ever built for a generator purging system (Fig. 1). This was built for the Pennsylvania Water and Power Co. for their Holtwood Steam Electric Station in Holtwood, Pennsylvania.

In this installation, it was decided that nine cylinders of CO_2 would be used, each having a siphon tube from the valve to the bottom of the cylinder, all being connected together to deliver 300 lb of CO_2 per hour. The cylinders were located outside of the building to eliminate hauling them in and out of the building, to facilitate replacement, and to reduce insurance rates.

A 12 kw automatic electric carbon dioxide vaporizer was supplied for this job. This vaporizer will deliver the required amount of CO_2 in gaseous form to the generator housing at a temperature of 100 F.

The consumption of carbon dioxide used to evacuate a turbine-generator housing is reduced considerably when the gas is vaporized by a vaporizer such as this. Ordinarily, when unheated CO_2 is passed directly into the generator housing, the temperature of the equipment and of the CO_2 will be in the neighborhood of −100 F. As the housing is filled, the gas takes on heat from the generator and housing and eventually warms up to about 0 F. By using the electric vaporizer, the inlet gas temperature is maintained at approximately 100 F. Calculating with Boyle's gas law, it can be shown that only 65 per cent as much CO_2 is required to evacuate a given generator housing if the gas is first heated to this temperature.

Assuming that you use or can install one of the three specified sources of carbon dioxide — dry ice converter with valve connected to bottom, cylinders inverted, or cylinders with siphon tube to the bottom — the problem of calculating the number of cylinders required and the time necessary for the purging operation becomes one of simple arithmetic.

continued on page 102

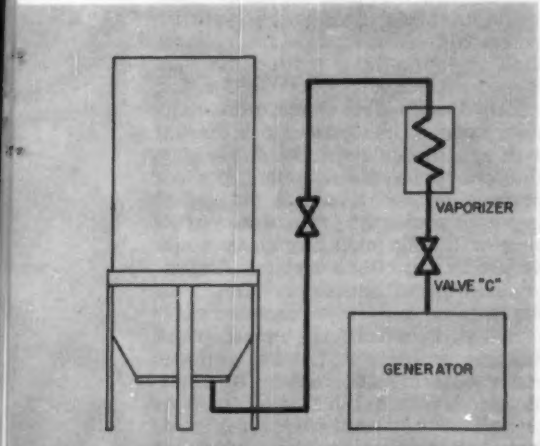
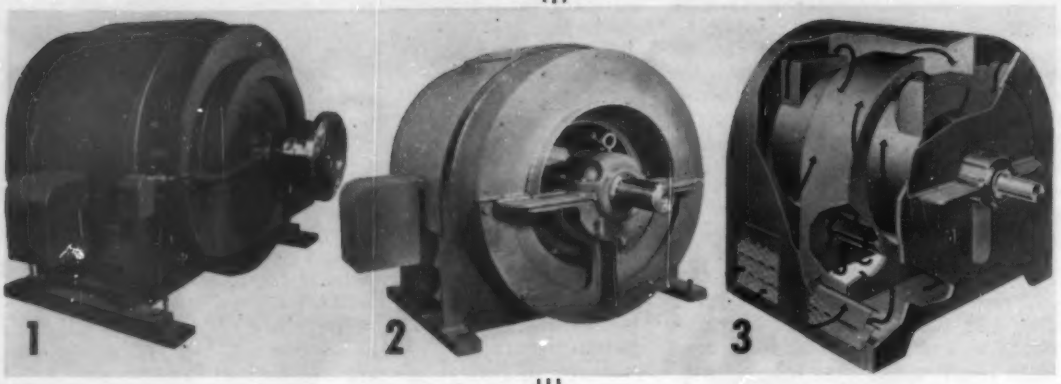


Fig. 4. Dry ice converter requires use of valve in line leading to vaporizer



Figs. 1 to 7. Motor enclosures. 1. Splash-proof. 2. Drip-proof. 3. Cutaway view of weather-protected. 4. External view of weather-protected. 5. Base-ventilated. 6. Explosion resisting cooled with an inert gas. 7. Explosion-proof.

Choose Motor Enclosure To Fit the Weather

With outdoor power plants on the increase, more and more station auxiliaries are being placed outdoors. Here's a review of the common motor enclosures, with costs compared for each type

By M. R. LORY* and J. F. HEIDBREDER†

ALL INDUCTION MOTORS are subjected to injurious atmospheric conditions, the degree depending on the application. No hard and fast rules can be given to determine which type of enclosure should be used for a particular application, but several general recommendations can be made.

This article concerns itself principally with motors larger than 250 hp. Some of the recommendations given are not valid for smaller motors because the extra charge for enclosures is less for small motors.

Injurious Atmospheric Conditions

Moisture: Most common damaging atmospheric condition is moisture. It can enter the motor as condensation when the machine is shut down, it can run into the motor or be carried in by ventilating air, or it can enter as rain or snow in motors outdoors or near open windows.

Moisture soaks into the walls and collects on the creepage surfaces of the insulation, and, if allowed to accumulate, will lower the insulation resistance until breakdown occurs. To minimize the bad effects of moisture, the motor manufacturer protects the windings with varnish treatments. The varnish fills up voids in the insulating material and also provides a protective coating for the insulation. One manufacturer impregnates the coils with a solventless synthetic resin which fills all voids in the insulation to prevent entrance of dirt and moisture.

Dirt: Conducting dirt is most dangerous. This kind works into minute cracks in the insulation, or collects on the creepage surfaces and reduces insulation resistance till the winding fails.

Abrasive dirt is found in such applications as cement mills and power stations using stoker-fired boilers. It may wear through the insulation in a few months. Special treatments on the windings can retard the effects of this abrasive dirt. Neoprene coatings cause the particles to bounce off rather than cut into the insulation, and increase the life of the windings many times.

Other forms of dirt are not directly dangerous to the operation of the motor, but still have adverse effects. Dirt may block the ventilation passages so the motor fails from overheating. Dirt may also absorb moisture and thereby keep it in intimate contact with the insulation.

Chemicals: Chemicals may attack and destroy the protective films of varnish on the windings, and also may attack the structural parts of the motor. It is not uncommon in chemical plants to have concentrations of acid which will dissolve the structural parts of a motor until it will literally fall to pieces. These chemicals penetrate the insulation, and in the presence of water they form conducting electrolytes which cause the windings to fail. One example is salt. Motors that have salt on and in the windings have a high insulation resistance when dried out, but the resistance drops almost to zero in a fairly short time as the windings absorb moisture. It is difficult to protect a motor from chemicals, although multiple varnish treatments do some good. An impregnation with synthetic resin will also give us exceptionally good resistance to chemicals.

Oil: Oil may get into motor from leakage from its own bearings, or it may be carried in from the surrounding atmosphere. It may soften and damage the protective varnish. Oil also catches dirt and makes it cling to the motor surfaces so it is difficult to remove.

Types of Enclosure

Drip-Proof: This is the most common type of enclosure. All motors with synchronous speeds of 500 rpm and above have this much protection without extra cost. A drip-proof motor is protected from water dripping or falling on it from any angle within 15 deg of the vertical. A typical drip-proof motor is shown in Fig. 2.

Splash-Proof: In the splash-proof motor, protective covers prevent water entering the motor from any direction within 105 deg of the vertical. The additional enclosures interfere with ventilation, so splash-proof

*Manager and †Design Engineer, Motor Engineering, Transportation and Generator Division, Westinghouse Electric Corp.

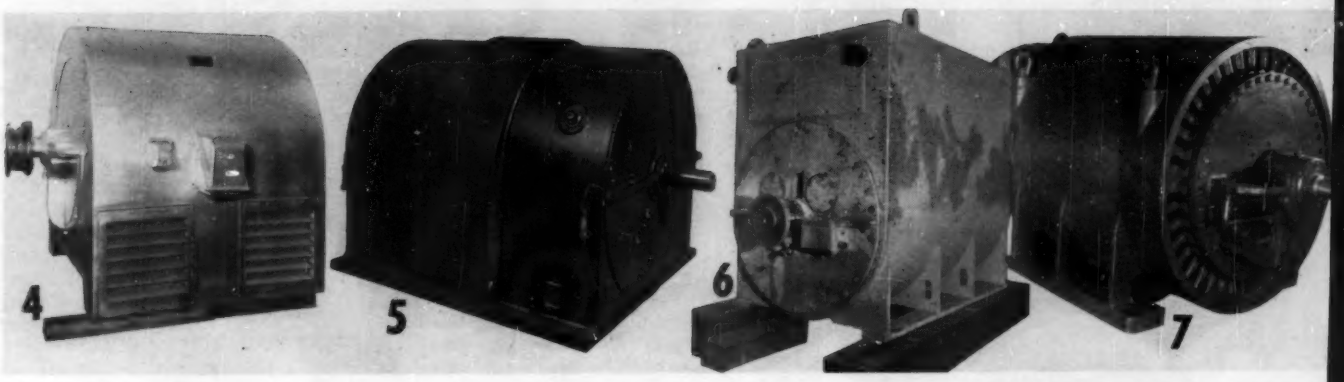


Table showing comparative costs for various enclosures for a 1000 hp, 900 rpm, 2300 volt, 3 phase, 60 cycle motor

Type of Enclosure	Comparative Cost per cent
Drip-proof	100
Drip-proof with screens over openings	102
Splash-proof — 50 C rise	115
Splash-proof — 40 C rise	142*
Weather-protected — 50 C rise	125
Weather-protected — 40 C rise	155*
Weather-protected with air filter and Thermoguard — 50 C rise	133*
— 40 C rise	163*
Force-ventilated	108*
Self-ventilated, base or pipe ventilated — 50 C rise	125
— 40 C rise	155*
Enclosed, self-ventilated with air cooler	159*
Enclosed, self-ventilated, cooled with insert gas	179*
Totally-enclosed, fan-cooled, 55 C rise	205*
Explosion-proof	226*

* These percentages vary with the rating of the motor. See manufacturers' published prices for other ratings.

motors usually have a rating of 50 C temperature rise instead of the standard 40 C rise for drip-proof motors. As a result, the splash-proof motor does not have a service factor. That is, it will not carry a continuous overload with safe temperature. At additional cost (shown in table), it is possible to obtain a splash-proof motor with a temperature rise of 40 C and such a motor has a normal service factor. Fig. 1 shows a typical splash-proof motor.

The use of splash-proof motors, at least in the larger horsepower ratings, is decreasing. Most indoor applications are served well enough by drip-proof motors. The splash-proof enclosure does not protect the motor adequately from rain and snow, especially if it is driven into the motor by high winds. For outdoor locations, it has become accepted practice to use weather-protected motors.

Weather-Protected: With the failure of standard splash-proof motors to give satisfactory service life outdoors, motor manufacturers were called on to design a motor that would be satisfactory for these applications. The use of outdoor motors is becoming rather common with the increase in the number of outdoor and semi-outdoor power stations now being built. Of course, totally-enclosed, fan-cooled motors (T.E.F.C.) would be satisfactory for such applications, but the principal reason for the outdoor station is to reduce the cost of construction. And in ratings of 500 hp and above, the large increase in motor cost for T.E.F.C. construction wipes out too large a part of these savings.

The weather-protected design is the newest of the standard enclosures, and was developed to give satisfactory outdoor performance with a cost that is substantially lower than the cost of a T.E.F.C. motor. Air flow direction is shown in Fig. 3. The large space between the inner and outer enclosure reduces the vertical velocity of the inlet air so that the combination of a sharp turn, sudden drop in velocity, and considerable vertical travel upward at low velocity effectively separates out any droplets of water carried by the inlet air.

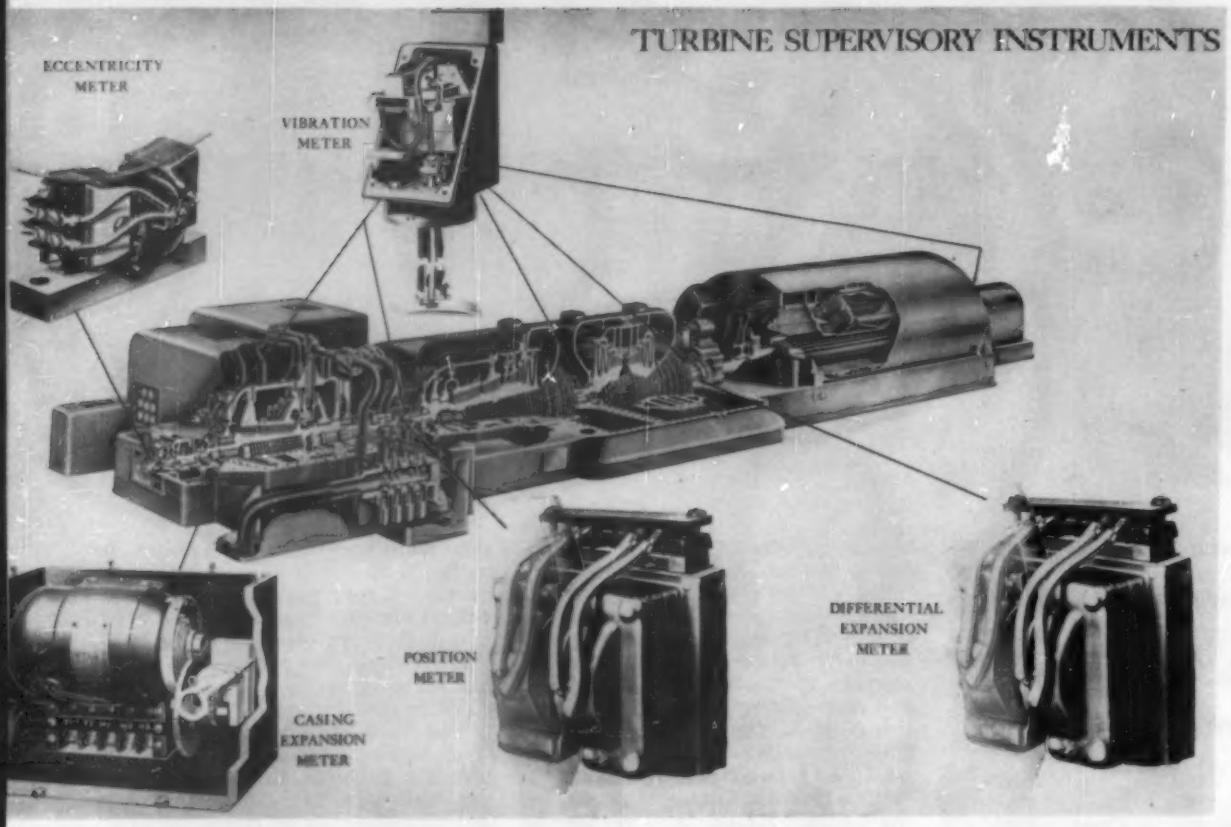
One of the most difficult atmospheric conditions to which these motors are subjected is rain driven into the motor openings by hurricane winds. To handle this condition, the inlet openings of each side of the motor are connected by a passage straight through below the ends of the inner enclosure, so that wind driven rain can blow straight through from one side to the other without passing into the active parts of the motor. A baffle is provided at the top of the motor to keep rain from being blown up and into the inlets into the inner enclosure. The restrictions in the internal ventilating passages maintain close to the normal amount of air passing through the machine regardless of wind velocities.

The outlet openings are also arranged so that there is a clear passage from one end to the other. A baffle in the bottom of the frame below the core prevents water from being blown up into the motor, even if a high wind blows a lot of rain through from one end to the other under the motor.

This type of motor, shown in Figs. 3 and 4, is suitable for all but the most severe outdoor applications. If dirt is a problem, the motor can be provided with filters. The filters can be changed easily by removing small covers over access openings in the outer enclosure. When filters are added, a thermostat should be provided, mounted on the stator end turns. This is necessary to give warning of excessive temperatures in case poor maintenance of the filter clogs and restricts the motor ventilation.

The weather-protected motor is not suitable if it is subjected to severe chemical contamination. This may be from salt, from a chemical process, or from a power plant that burns refinery wastes. If a motor must withstand severe chemical atmospheres, there are three choices. If the contamination is very local so that a supply of clean ventilating air is available within a reasonable distance, the force-ventilated motor is the cheapest choice. If clean air is not readily available, but a supply of cooling water and a drain are available, the next most economical arrangement is an enclosed, self-ventilated motor with air cooler. If neither clean air nor cooling water are conveniently available, a totally-enclosed, fan-cooled motor should be used.

Force-Ventilation: In some installations, it may be desirable to enclose the motors so room air does not pass through them. Reasons for the enclosure are to protect the motor from severe atmospheric conditions, to reduce noise, to keep explosive vapors out of the motor, and to keep heat from the motor losses from being added to the room air. The cheapest form of enclosed motor is the force-ventilated motor. In this type, suitable venti- *continued on page 96*



Cutaway section of large steam turbine generator showing the location of five different supervisory instruments

Turbine Supervisory Instruments Give Vital Operating Data

Size and speed of modern turbines require special instruments for measuring shaft eccentricity, vibration, casing and other expansion

IN ADDITION to the information obtained from the familiar instruments and gages such as temperatures, pressure distributions, speed and etc. there are at least five additional facts that are extremely important in the starting and operation of large modern turbines. Instruments are available to record: 1. the straightness of the rotor when starting, 2. the expansion or contraction of the turbine casing, 3. the differential expansion between rotating and stationary parts, 4. the position of the shaft relative to the stationary elements, and 5. the magnitude of the shaft vibration. J. C. Spahr, Assistant Sect. Manager, Turbine Engineering, Steam Division, Westinghouse Electric Corp., Philadelphia, gave the following description of these instruments in paper No. 53–5–1, before the National Instrument Conference in Chicago.

Shaft Eccentricity Meter

When a turbine is shut down the hot vapors in the turbine rise to the top of the casing, giving an uneven temperature distribution which may result in a bowing of both the turbine shaft and casing. To minimize the amount of distortion, modern steam turbines are equipped with a turning gear which slowly rotates the turbine rotor while the unit is cooling. While the turning gear is effective in reducing the amount of shaft distortion a check for truth should be made on every start up. When shaft distortion exists, the unit must be rolled at slow speed until the parts are uniformly heated and the shaft straight.

The shaft eccentricity meter will automatically indicate and record the amount of eccentricity existing. Two pick-up coils are located at the end of the shaft extension beyond the bearing where the effect of the shaft bending is the greatest. The location and arrangement of the eccentricity meter pick-up coils is shown above.

Two iron pick-up coils diametrically opposed are supported from the pedestal housing with air gaps between the pole pieces and the periphery of a soft iron disc on the turbine shaft. When the shaft is straight the air gaps are equal and the bridge circuit of which both coils are a part is balanced. When the shaft is bowed the air gaps are alternately increased and decreased by the eccentricity of the disc as the shaft rotates. This unbalance in air gap results in a periodic unbalance in the bridge circuit which is used to operate an indicating or recording meter showing the eccentricity of the shaft in thousandths of an inch.

Thermal Expansion

Thermal expansion of the turbine parts starts with admission of steam for the slow roll operation, continues while bringing the unit to speed and reaches a maximum when the unit is fully loaded. The magnitude and variations in expansion will depend on the type and size of the turbine, but for any given unit the expansion will follow the same pattern on each start up and loading cycle provided the unit is loaded in the same manner and is allowed to expand freely.

There are two functions of the thermal expansion which are closely associated and each is important for

proper operation. The first function is the rate of expansion of the turbine casing which is measured and recorded by the casing expansion meter. A record of the cylinder expansion would be sufficient for proper operation provided the stationary and rotating parts expanded at the same rate; this however is not the case. As steam is admitted to the turbine the turbine rotor, because of its smaller mass, will heat faster and therefore expand faster than the turbine casing. This differential expansion between stationary and rotating parts is the second function of thermal expansion important to the operator and is measured by the differential expansion meter.

Turbine Casing Expansion

To allow freedom for expansion, the turbine is anchored at one end to the foundation while the other end is free to slide in an axial direction. Keys located between the turbine exhaust feet and the foundation sole plates permit expansion of the exhaust casing but anchor the turbine on the exhaust centerlines. Alignment of the sliding pedestal is maintained by means of a well lubricated key in the pedestal base. A smooth continuous motion of the pedestal as it slides along the base is a good indication that expansion is progressing normally.

The instrument is simple and employs the synchrotic position indicator principal in its operation. It consists of two small polyphase induction motors with single phase stators and three phase rotors. One motor transmits and the other receives. With the rotors interconnected electrically and the stators connected to the same sources of single phase power, the receiver rotor follows exactly the rotation of the transmitter rotor. The transmitter motor is located on the pedestal base. By a rack and gear device any motion between the sliding pedestal and the pedestal base results in a corresponding rotation of the transmitter rotor. This rotation is transmitted to the receiver motor located in the recorder and geared to the recording pen. The relative motion, therefore, is traced graphically by the recorder. The slope of the trace indicates the rate of cylinder expansion and the trace itself indicates the magnitude. Any sharp deviation in the slope of the trace indicates non-uniform expansion or contraction which warns the operator of irregular operation.

Axial clearances between rotating and stationary parts are provided to allow for the differential expansion in the turbine. The amount of differential expansion existing during the start up cycle will depend to a large extent on the speed at which the turbine is heated up. The differential expansion should be substantially constant for any given loading on the turbine. Any sharp variations from the established pattern of differential expansion should be a warning to the operator to investigate the situation and determine the cause.

The differential expansion meter operates on the same magnetic principal as the eccentricity meter.

Shaft Position Meter

The axial position of the turbine shaft with respect to the stationary parts is maintained by the thrust bearing. The thrust bearing also carries the resultant unbalanced axial loads. As the electrical load changes there will be a change in the thrust loading causing a small displacement of the rotor. This displacement should be constant for any given set of conditions. Once having made a complete check of the internal changes in the machine under various conditions of operation we feel safe in assuming that as long as the relation of the fixed position of the machine remains constant no internal interference will be experienced. Any variation in the established thrust bearing position may mean excessive thrust loading or thrust bearing wear and should be investigated immediately. The shaft position recorder will make a permanent record of shaft position and supply the operator with the history of past performance.

The shaft position meter also operates upon the same magnetic principal as the eccentricity meter.

Shaft Vibration Meter

Continuous records supply the only reliable data on shaft vibration for modern turbine generator units. Gradual changes in vibration and amplitude may not be noted by the most experienced operator but are immediately apparent when placed on a continuous chart.

The method of measuring vibration from the bearing cap or pedestal with a pedestal vibrometer was adequate and satisfactory for the 1,800 rpm turbine. However, the situation is quite different for the modern high pressure, high temperature, 3,600 rpm turbines. It was found that on a 3,600 rpm turbine the bearing pedestal could be reasonably quiet while the turbine shaft could be vibrating beyond acceptable limits. This experience proved the inadequacy of the pedestal or bearing cap vibration measurement and as a result a shaft vibration meter was developed to replace the pedestal vibrometer. This instrument detects the vibration at its source, i.e. the turbine shaft. The shaft vibration meter has now been used for a number of years, and is now becoming the accepted method.

The shaft vibration recorder consists of a seismically mounted electromagnetic pick-up whose movable coil is actuated by follower shoes on the turbine generator shaft.

World's Largest Pump-Turbine

WORK HAS STARTED on the pump-turbine which is to be installed in the Hiwassee Dam on the Hiwassee River, in Cherokee County, western North Carolina, George K. Leonard, TVA's Chief Construction Engineer, reported.

This unusual machine, which will be the largest of its kind in the world, will operate as a conventional turbine for the generation of power during peak load hours, and as a pump to return water to the lake behind the dam during off-peak hours. Such a cycle is economical only under conditions where generating capacity and energy have appreciably greater value during peak load than off-peak load periods.

Production of power has been temporarily discontinued at Hiwassee, and the flow of water from the lake has been stopped.

This will have the natural effect of lowering the Apalachia Lake, immediately downstream. In addition, TVA engineers are taking advantage of the situation and will lower Apalachia Lake still farther to permit necessary maintenance work on the Apalachia powerhouse tunnel.

The area immediately below Hiwassee Dam will be pumped out and a cofferdam will be constructed. Following completion of the cofferdam, the enclosed area will be pumped dry so that excavation work can begin, to be followed by concrete placing. It is estimated that production of power from Hiwassee's present single generator will be resumed thereafter.

Work has been completed on the concrete-making plant, the carpenter shop, machine shop, warehouse, gas and oil tanks, and administration building.

The pump-turbine itself is under construction at the Allis-Chalmers Mfg. Co., in Milwaukee. Model tests have been successfully passed, and design and construction work is going forward.

The pump-turbine will be more than 22 ft in diameter. It will be capable of generating 59,500 kw, or 80,000 hp at 190-ft head. It will be able to pump 3900 cu ft of water a second against a head of 205 ft. The pumping capacity will be equivalent to 1,750,000 gpm.

It is expected that the unit will go into operation in October, 1955.

First pump turbine to go into operation in U. S. is the 8500-kw unit at Flatiron Pumping and Power plant, POWER ENGINEERING, September '54.

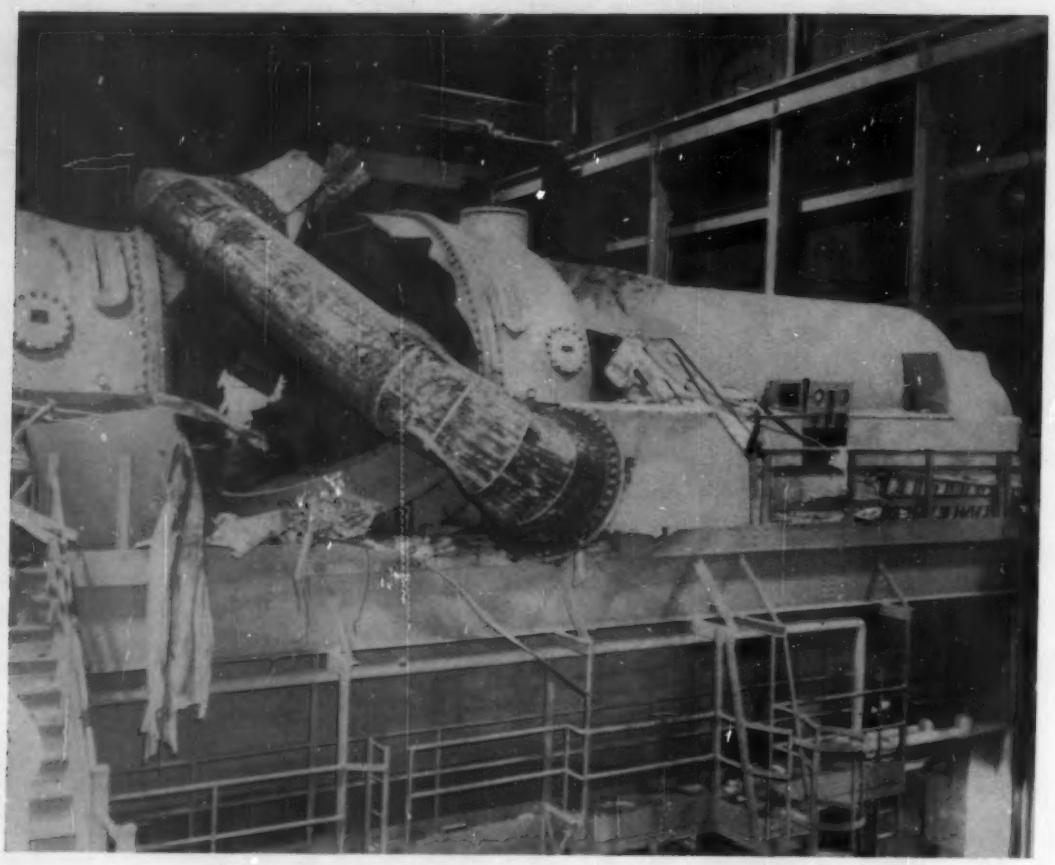


Fig. 1. Cross-over pipe lands on low-pressure turbine; daylight shows through

Commonwealth's Ridgeland No. 4 Turbine Explodes

Floods knocked out Commonwealth Edison's Fisk and Crawford Stations last October. Now they have more troubles as the newest unit in their newest station explodes. Score: 2 killed, 640-mw out

Fig. 2. Clock on control room wall shows exact time of the disaster; 11:19 P.M., December 19

UNIT NO. 4 was going on the line after a week-end shutdown for boiler maintenance. The best available word has it that all was proceeding normally. The unit (cross-compound, 160-mw) was at or near rated speed, and then the low-pressure turbine exploded.

Two shift engineers, George A. Thorsen (34) and Clarence T. Jorgensen (36), were killed; five others were injured. Fifteen other workers present in the plant were unharmed.

Unofficial word has it that the cause of this disaster was failure of the low-pressure turbine shaft. At this stage of the investigation, however, we do not believe it possible to determine definitely whether this is cause or effect.

Engineers appointed to the coroner's jury investigating the two deaths are: Ovid Eschbach, dean of Northwestern University's technical institute; N. C. Dezendorf, president

All photos by the Chicago Daily News

Fig. 3. Close-up view of ruptured spindle. Unconfirmed theory has it that this may have been the cause of the explosion, but it might have been one of the effects

of Electro-Motive Div. of G. M.; Jerry Kanter, director of the Crane Co. engineering laboratory; Joseph Burgee, architect; and W. G. North, retired construction company executive. At POWER ENGINEERING's press time, no statement had been issued by this jury.

Manufacturers of the turbine generator said, in a statement issued December 21, "We have placed all our facilities and technical resources at the disposal of our engineers, who are working with Commonwealth engineers in a complete investigation of the accident. Until the results of their investigation are available, we do not think it is timely for us to comment."

This unfortunate occurrence is the latest in a series of accidents that have befallen several large steam turbine generators within a relatively short period. Not long ago, in a new 165,000-kw unit at the Philadelphia Electric Company's newest station, a failure occurred in the main shaft and wrecked the unit. Fortunately, no one was killed in this accident — although two of the station personnel were standing beside the unit when it exploded. It is reported that a slight defect, repaired during manufacture of the shaft, may have caused this failure.

About a year ago in one of the Canadian stations, a large British turbine generator unit exploded; about one month later, a second one did the same.

In these cases, cause of the accident was failure of the end ring on the generator.

A 165,000-kw generator costs in the neighborhood of $10,000,000. Certainly, if we are going to have to build larger and larger machines than these, at even higher cost, the power industry will do everything possible to prevent future failures of this nature and maintain its previous fine safety record of many years.

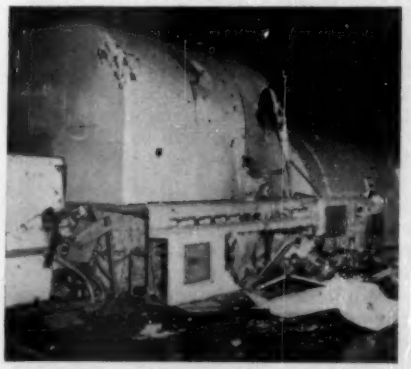


Fig. 4. An innocent by-stander was severely damaged by flying debris. All units were knocked out by the explosion, but Nos. 1, 2, and 3 are being repaired and returned to normal service

C. T. BAKER, Consulting Engineer, EXPLAINS

Why the Air-Conditioning Cost Too Much

Air-conditioning equipment for this plant was well designed and big enough for the job. But condensing pressures and power costs were much higher than they should have been. Are you sure you don't lose money this way?

TO PROVIDE maximum comfort for its guests in summer, a modern motel was air conditioned. The equipment selected for this service was good, and the 68-tons installed capacity was adequate for the conditions. All the air cooling units were floor mounted, ranging in size from a small three-ton unit to fifteen tons. An orthodox system of metal ducts delivered conditioned air to the rooms in each group of buildings. Some of the units used Freon 12 and others Freon 22 as the refrigerant. No difficulty was experienced in maintaining the design temperature and humidity, yet there were complaints from the owners. Condensing pressures were abnormally high and the cost of power was distressing.

A well on the premises supplied water for all purposes, including make-up for the induced draft cooling towers — one tower for each of the self-contained air conditioning units.

High Condensing Pressure

Principal cause of high condensing pressure was dirty condenser tubes. The residue which collected in the basin of the towers was responsible for the partial closing of the tubes, as this basin water was pumped through the small tubes of the condenser and returned to the towers to be cooled for re-use. Reduced water flow (plus the insulating effect of the deposits left behind as evaporation took place) not only resulted in abnormal condensing pressures but caused loss in capacity.

While provision had been made for the continuous draining of a sufficient quantity of water from the tower basin to keep down the concentration, only superficial attention was given to this very important operating detail. When analyzed, water samples taken from the basin of one tower showed an almost unbelievable quantity of deposit.

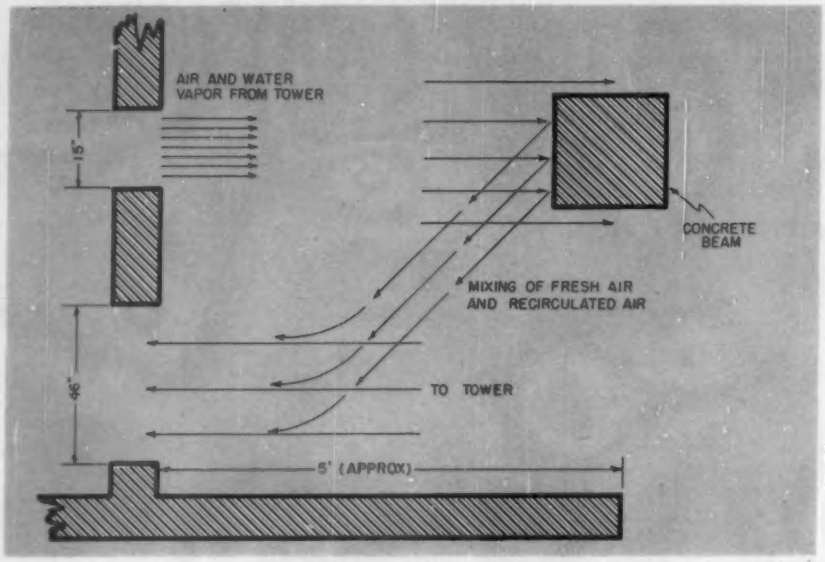


Fig. 1. Beam too near wall opening made warm vapor recirculate at increased temp

Engineers usually select a cooling tower with sufficient cooling capacity to bring the temperature of the condensing water leaving the tower as close as possible to the prevailing wet bulb temperature. In the situation under discussion, the approach to the wet bulb was within the limits of good engineering practice, yet the leaving water temperature was higher than it should have been for good condenser operation. An investigation brought to light some interesting facts.

The wet bulb temperature of the air actually entering the cooling towers was anywhere from 2 to 4½ deg higher than the prevailing wet bulb temperature measured some 30 to 50 ft from the air inlets to the towers.

It had been necessary to place each cooling tower inside the building. An induced draft fan drew air through a wall opening, as shown in Fig. 1, and then through the tower, finally discharging warm humid air through a similar opening near the top of the wall.

Fig. 1 shows the relation of the warm air discharge to a concrete beam that supported a portion of the roof. Much of the warm air, striking the beam, was deflected downward, and was then pulled back into the inlet air opening at the bottom. The inevitable result of this condition was an increase in the wet bulb temperature entering the cooling tower to about four deg above the normal measured about 30 ft distant. This high entering wet bulb temperature naturally resulted in a higher water leaving temperature and consequently, higher than normal condensing pressures. This building is cooled by two air conditioning units — a 15-ton size for the second floor and a 10-ton for the first, each with its own cooling tower.

Fig. 2 shows the size of the air inlet and outlet openings provided for the entering and leaving tower air. Notwithstanding that the 15-ton tower requires considerably more air than the one serving the 10-ton cooling unit, the openings provided in the wall were the same for each tower. The manufacturer specified 4500 C.F.M. of air for the 15-ton tower and 3000 C.F.M. for the 10-ton.

This situation is now being corrected. First, the warm air discharges from the two cooling towers are being re-located so as to release air clear of the building. Second, much larger inlet and outlet openings are being provided in the building walls to enable the induced draft fans to operate under design conditions.

Another building of the group was served by a 15-ton air conditioning unit and cooling tower. For some un-

determined reason, the tower air inlet and outlet openings had been fitted with fancy louvers. This had materially reduced the net, or effective opening and of course, also reduced the air handling capacity of the fan.

After removing the louvers, the increase in air handling capacity of the fan resulted in a drop of 2½ deg in the temperature of the water leaving the tower and a perceptible drop in condensing pressure.

The cooling tower of this building was also handicapped by the short-circuiting of warm, humid air from the air discharge outlet. The hindrance had been sufficient to raise the wet bulb temperature 4½ deg above the normal measured some feet distant from the tower inlet. This condition is being corrected by diverting the warm discharge air away from the air inlet.

The office of this development was air conditioned by a 3-ton cooling unit and a companion cooling tower. As the tower had to be located in the room that housed two gas-fired water heaters, it was not safe to draw air into the room from the outside to supply the fan, as under certain conditions, this could result in a deficiency of oxygen, causing the gas flame to be extinguished. It was then required that the air be supplied through a duct from the outside, connected directly to the tower inlet with an air-tight connection between the tower and the duct.

This tower had two air inlet openings, one on each side near the bottom of the assembly. One opening was completely blanked-off and the other was connected to a small louvered transom above a small door which opened to the outside. The net opening of the transom above the door was reduced at least 50 per cent by the louvers. Needless to say, the tower received only a small percentage of its actual air requirements.

This condition is being corrected by removing the louvers above the door and installing a second air supply duct connecting the unused air inlet of the tower to the outside.

If a cooling tower such as the one used in this installation is fitted with two standard air inlet openings, it cannot possibly operate efficiently with one of the openings completely blanked-off.

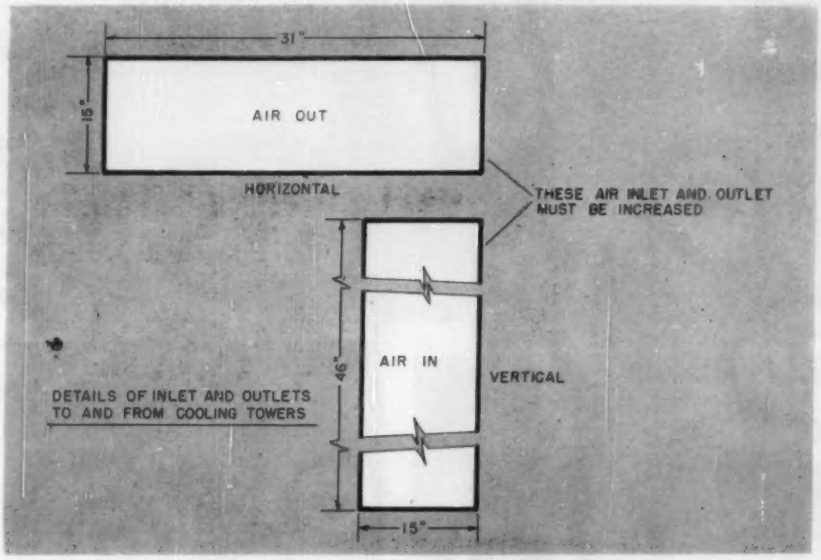


Fig. 2. Size of inadequate ducts for motel air conditioning system's cooling towers

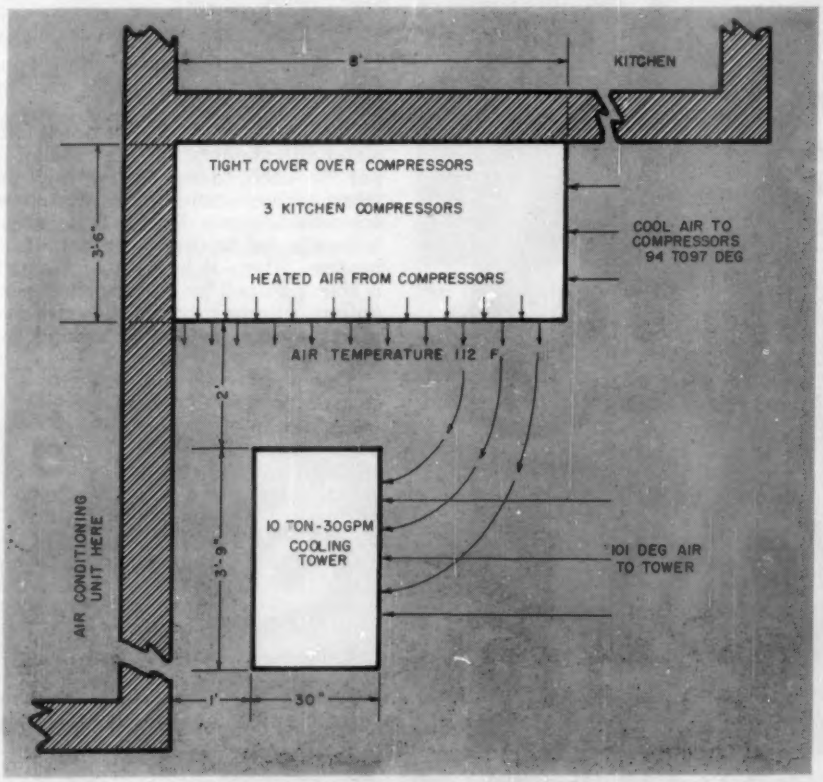


Fig. 3. Showing poor location of cooling tower for motel air conditioning system

Restaurant Was Penalized

The restaurant serving the motel was conditioned by a 10-ton air cooling unit. Fig. 3 shows the location of the cooling tower which serves this unit and the proximity of the refrigerating plant compressors and air cooled condensers.

The temperature of the air leaving the "dog house" which enclosed the refrigerating plant compressors and condensers was 112 F. Sufficient quantities of this warm air short-circuited to the tower to raise the inlet temperature to 101 F. There was also a pick-up of 3 deg in wet bulb temperature resulting from moisture being picked up from the kitchen exhaust and similar sources.

During the coming winter, the kitchen refrigerating equipment will be re-located to eliminate the disadvantages of the present arrangement.

Water Conditioning

In addition to the changes and improvements already under way, the condensing water will be treated to remove troublesome properties and a continuous drain-off from the basin of the towers will be maintained in a quantity approximately equal to the amount of water evaporated.

If you want copies of any articles in this issue, don't tear them out; others may want to see them. Write to the Editor for a tear sheet, or use one of the prepaid postcards elsewhere in this issue.

H-T Water Heats Limestone Base

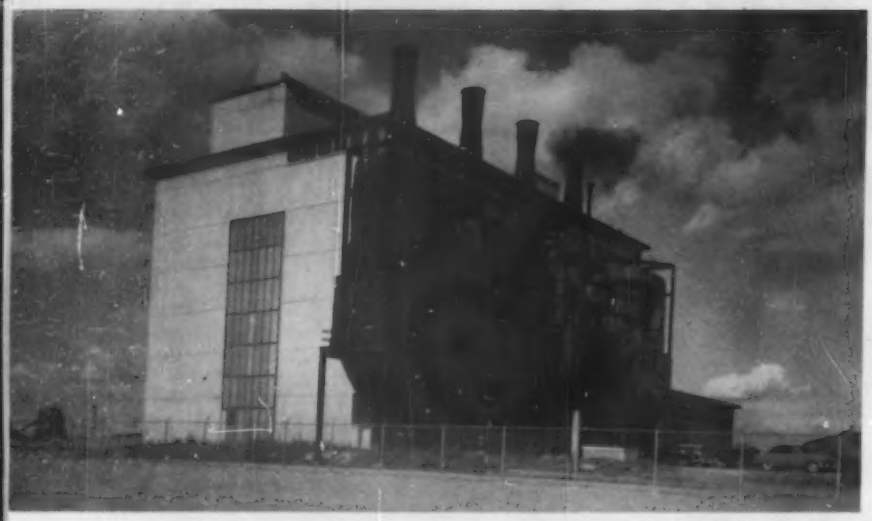


Fig. 1. General view of heating plant shows mechanical fly-ash collectors and electrical precipitators for each boiler mounted outside building

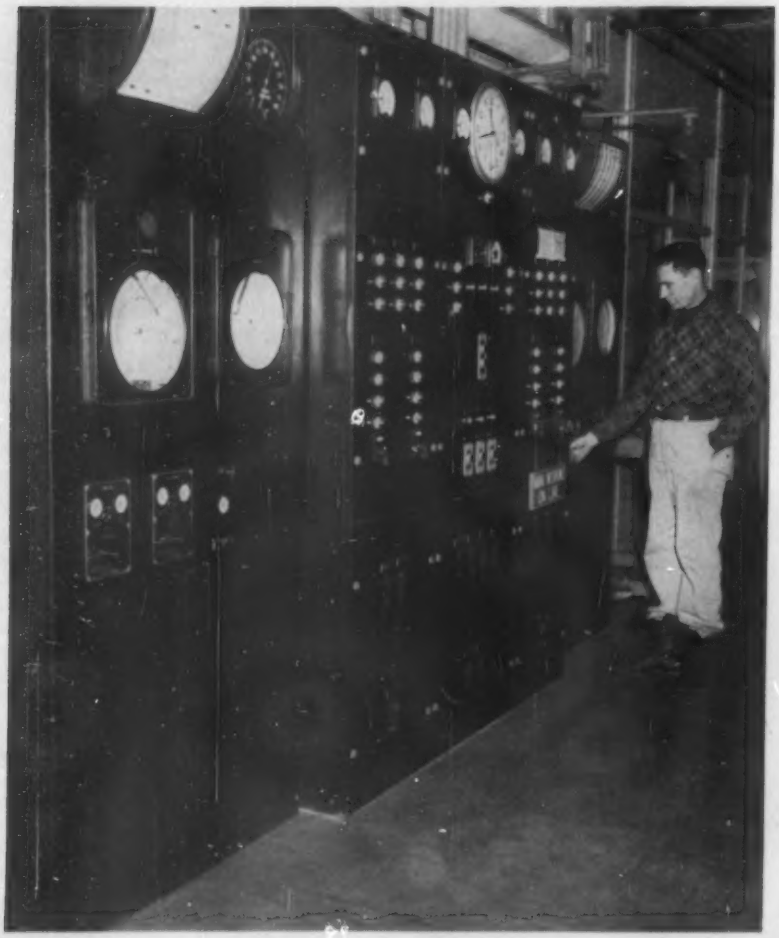


Fig. 2. Each pair of the four boilers is controlled from this central control panel, mounted on the operating floor opposite the boilers as shown in Fig. 3

Four 75,000-lb-per-hr boilers supply steam that heats water for distribution throughout Air Force base at Limestone, Maine

IN THE NORTHEAST corner of Maine, at Limestone, the U. S. Air Force has established one of its largest bases. It covers an area of many square miles, is staffed by people enough to inhabit a small city that has been established there and is heated throughout by high-pressure, high-temperature water supplied by the steam plant shown on these pages. Naturally it is not permissible to give specific figures on the size of this base but the Air Force has consented to the release of these photographs, since they would not reveal anything about military operations as such. The base has recently been renamed the Loring Air Force Base, in honor of the late Major Charles J. Loring, Jr.

Use of hot water for heating this base follows a practice that has been carried out more and more in this country in recent years, especially in a number of air bases, at least one navy yard, and a number of well-known industrial power plants.

Plant Burns Coal

The hot-water heating system at Limestone was designed and constructed for the Air Force by the Corps of Engineers, U. S. Army. The boiler house, Fig. 1, contains four water-tube boilers, rated at 75,000 lb per hr each, designed for 250 psi steam pressure, and fired with coal by spreader stokers. Steam from these boilers is fed to direct-contact water heaters, where it heats water, which is then pumped by motor-driven centrifugal pumps through the extensive piping system extending around the base.

The plant does not generate any electric power but receives it from a combination of sources. Outside local utility companies have connections through various substations for supplying electric power. Another source of power is a diesel-engine generating plant built by the Corps of Engineers and containing four new 2500-kw diesel-driven generators and three older 1000-kw diesel-driven generators.

Water for the base is supplied by the base pumping plant outside the base. For use in the boilers and hot water heating systems, the water is filtered and treated in zeolite softeners. The heating system water recirculates, so that only about ½ per cent makeup is required for the boilers.

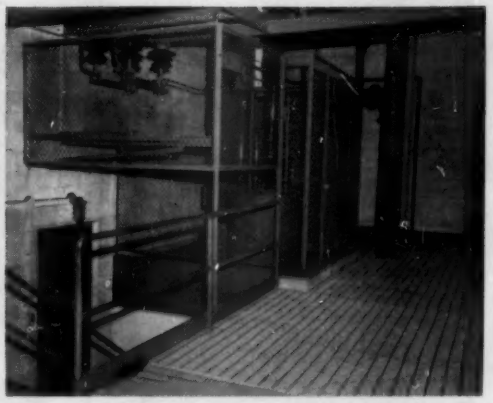


Fig. 4. Transformer and rectifier cubicle, from which electrical power is supplied to electrostatic precipitators installed following the mechanical dust collectors, both as shown in Fig. 1

Fig. 3—Left. Firing aisle, four 75,000-lb-per-hr boilers in Limestone heating plant. Coal supplied from overhead bunkers is fed to furnaces by traveling-grate spreader stokers shown here

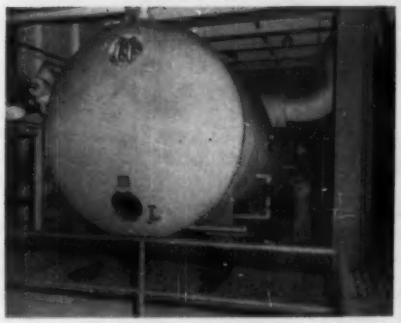


Fig. 5. Direct contact-type high-temperature water heater, with capacity of 1,000,000 lb hot water per hr, in which steam from boilers at about 175 psi mixes directly with water to heat it for circulation in system. Because water is cascaded through steam in heater, it is called, in the plant, a cascade heater. System water is usually kept at 8.5 pH

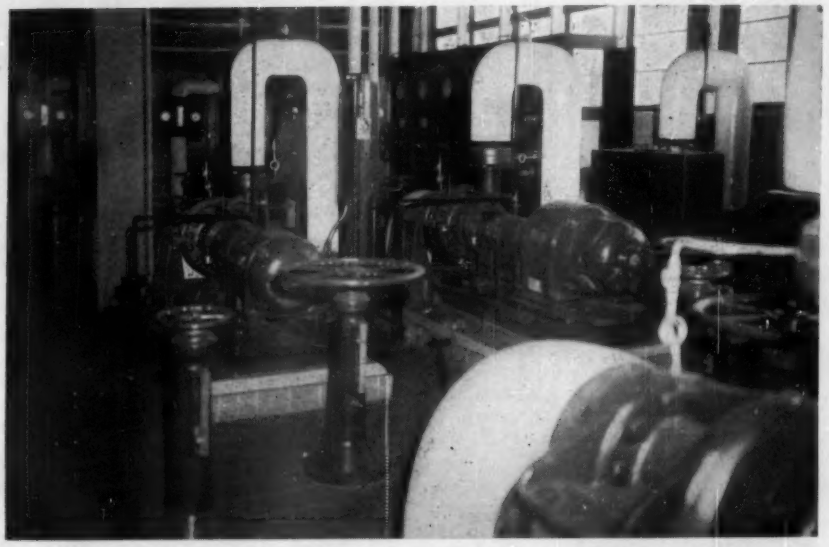


Fig. 6. Two of the four centrifugal pumps, each with a capacity range from 400 to 1600 gpm, driven by induction motors, which draw hot water from direct contact heaters, Fig. 5, deliver it to the heating system, add pressures ranging from 40 to 75 psi, depending on conditions. On panel at rear is a Btu meter used for measuring total heat in water that is delivered to heating system

Fig. 7. This is the electrical switchgear room for distributing power to all motors and lighting circuits throughout the Limestone heating plant

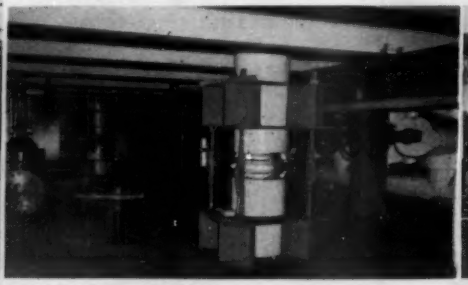


Fig. 8. Boilers deliver steam to common header from which this system of piping and valves can feed it to the direct-contact (cascade) hot-water heaters

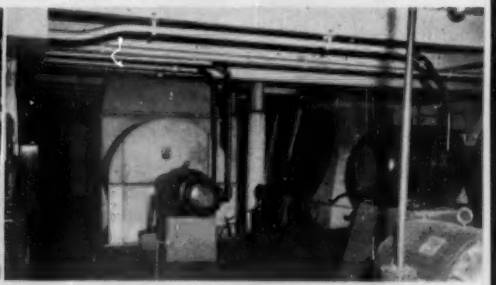


Fig. 9. View in fan room. For each boiler there is, at left, an F-D fan, and, at right, two I-D fans, one constant-speed, one variable-speed motor drive

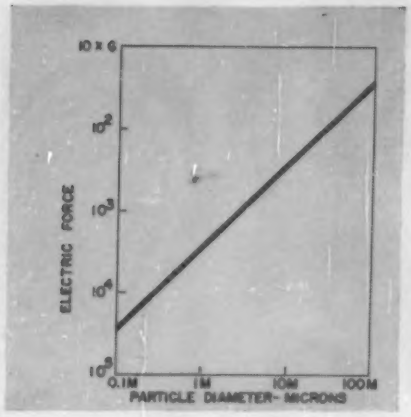


Fig. 1. Comparison of electric and gravitational forces acting on particle. On this diagram, electric force is expressed in terms of gravitational force

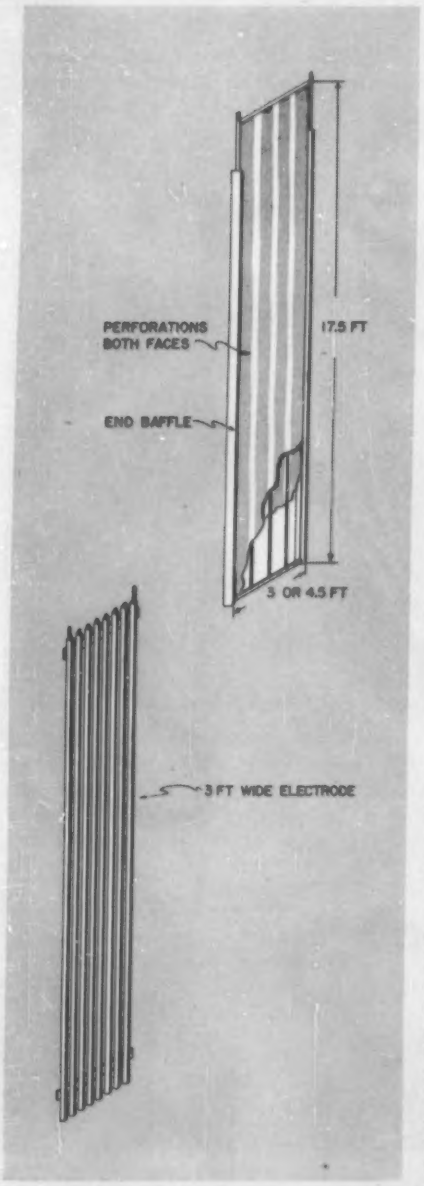


Fig. 2. Common types of collecting electrodes. Right: Perforated or expanded metal electrode. Left: V-plate electrode

This New Rapper Improves Electrostatic Precipitators

Collector plates in most older types of precipitators were cleaned by intermittent shaking. Now magnetic impulse rapper gives continuous cleaning, and eliminates puffs and clouding at the stack

By C. E. BEAVER*

IN AN ELECTRICAL precipitator, gas containing particles in suspension is passed between highly charged electrodes, under which conditions electric forces act on the individual particles and cause them to be collected on the electrode surfaces. The rate of particle collection and the effectiveness of the process increase in direct proportion to the strength of these electric or Coulomb forces.

Basically, an electrical precipitator must perform two essential tasks: first, an electric charge must be conferred on the suspended particle, and second, the particles must be subjected to a strong electrical field to insure their removal from the gas stream.

Precipitator Operation

In practice, electric charging of the particles is accomplished by means of ions produced in a d-c corona discharge. The collection of charged particles may be carried out by passing the charged particles between condenser plates in the absence of a corona discharge. If this is done, the precipitator is described as a two-stage type because the charging and collection are effected in two stages. This type has proved successful for industrial gas cleaning. The two-stage type is used primarily for air-cleaning applications where the amounts of ozone and oxides cannot be tolerated in the quantities generated with the corona discharge method. For example, under typical precipitator operating conditions the charge acquired by a particle of 10 microns diam. (1 micron is 1/1000 of a millimeter) is about 25,000 electrons, while the precipitating or collecting field is about 4500 volts per centimeter. The Coulomb force acting on the particle is then about 300 times the gravitational force, assuming a spherical particle of unit density. Comparison of the electric force with the gravitational force acting on particles over a wide range of particle sizes is shown in Fig. 1 where, for example, the electric force acting on a particle of 1 micron diameter is 3000 times that of gravity. Thus the electric force is very large compared to gravity, especially for the finer particles which in practice are the most difficult to collect. It is the existence of these relatively powerful forces which accounts for the striking effectiveness of electrical precipitation for separating fine particles from gases.

It was noted earlier that much of the growth in the use of electrostatic precipitation may be attributed to the precipitator's successful adaptation to the growing needs of the power industry.

For instance, concrete plate collecting electrodes were used in the early fly ash precipitators, but they have been abandoned in favor of the lighter and cheaper fabricated metal electrodes. The metal electrodes have taken various forms, such as perforated or expanded metal plate, V-plates, rod-curtains, and various hollow electrodes with pocket arrangements on the outside surface for conducting the precipitated dust to the hoppers in quiescent gas zones.

The perforated or expanded metal plate, Fig. 2, has a large number of closely-spaced holes which hold the ash, while the end-baffles on the plate shield the perforated surfaces from the direct scouring action of the gas. The V-plate, shown in the same illustration, is a form of shielded pocket electrode, and is particularly useful in retaining large and gritty ash particles. The ash collects in the series of vertical slots between the V's, from which it is not easily eroded and yet finds a direct shielded path to the hoppers.

Use in Cyclone-Fired Boilers

Increased capacities and efficiency have been somewhat encouraged by the recent trend toward ground-level installation, although in the past most precipitator units had been located on the roof. The ground-level installation can also be more readily enlarged than a roof site.

Another successful innovation has been the adaptation of the precipitator to the cyclone-type boiler. While the amount of fly ash discharged from this type of boiler is less than in the normal type of pulverized coal-fired boiler, precipitators have been utilized on several of these installations for the collection of fly

*Research Corporation, Bound Brook, New Jersey

ash. The primary reason for this application is the fact that the suspended matter is extremely fine. There is also the wish on the part of the industry to take every practical measure to insure that material discharged to atmosphere is reduced to a minimum.

Most fly ash precipitators are duct-type with horizontal gas flow to handle large volumes of gas and large quantities of ash. Duct width has to be a compromise. The more collecting plates you can get into a shell, the more dust you can precipitate, but if you have too many plates they will not be rigid enough, nor will there be enough dust build-up space between the electrodes. A duct width of 8 in. has been commonly used on our precipitators, and appears to represent the best compromise between these variables.

Precipitator shell dimensions are determined by the maximum permissible gas velocity in the precipitation zones and by the total collecting electrode area necessary to obtain the required collection efficiency. In practice, the practical dimensions for the active precipitation zones in fly ash precipitators have been 12 to 20 ft in height and 9 to 24 ft in length in the direction of gas flow. Most usual location for the precipitator is between the outlet of the air preheater and the inlet of the induced draft fan.

Precipitator construction is illustrated in Fig. 4 in which the essential parts are the high-tension frame and corona wires, collecting plates, enclosing shell and supporting frame, hoppers, and the electrode rappers. Fig. 5 shows a new precipitator under construction.

Corona discharge electrodes are usually round steel wires of about 0.1″ diameter, or equivalent twisted-square wires, hung in the ducts about 6″ apart. The discharge wire support frame is suspended from porcelain insulators mounted in suitable housings on top of the precipitator shell.

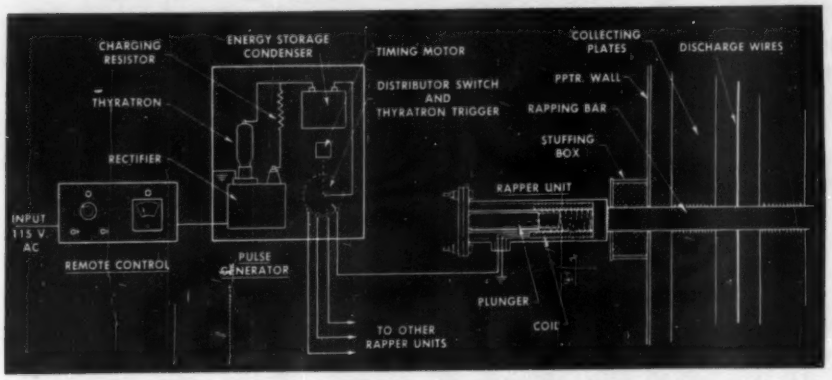


Fig. 3. Schematic diagram of magnetic impulse rapper for electrostatic precipitator

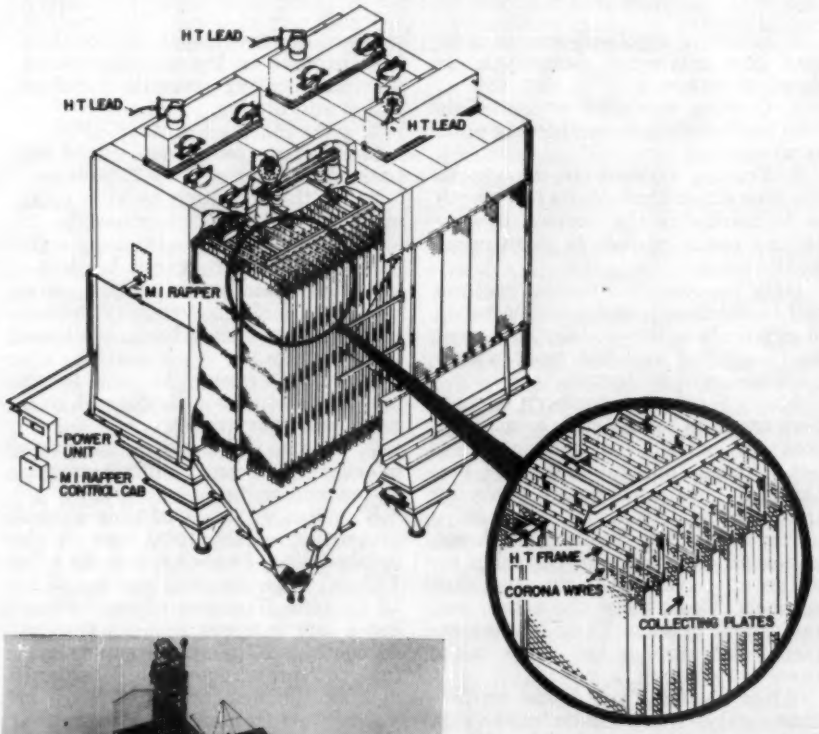


Fig. 4. Above: Basic structure of typical fly ash precipitator. Inset: Enlargement showing relationship of corona wires and collector plates

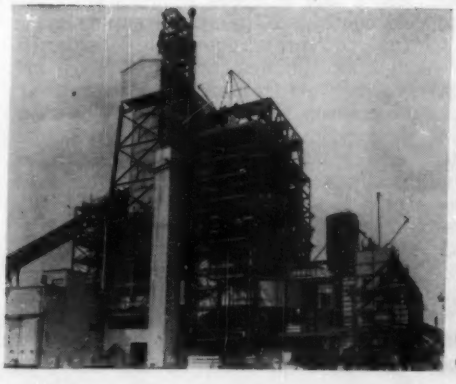


Fig. 5. Left: Installation at Martin's Creek station of Pennsylvania Power and Light Co. showing part of precipitator at extreme right of photo

Magnetic Impulse Rapper

One of the most important precipitator design innovations in recent years is the magnetic impulse (MI) rapper.

A prerequisite of efficient electrical precipitation is the removal of accumulated deposits from the electrodes. This is necessary not only to prevent choking the ducts but also to maintain best electrical conditions in the precipitation zone. The deposits are usually dislodged by mechanically jarring or vibrating the electrodes, a process generally referred to as "rapping." In some fly ash precipitator applications, particles tend to build up on the discharge electrodes as well as on the collecting electrodes, and this may occur to such an extent that the corona discharge is stifled and precipitation efficiency is impaired. In these cases it is necessary to provide effective rapping means for both the discharge and the collecting electrodes. Far from being a minor adjunct in electrical precipitation, rapping is of primary importance in determining over-all performance and has been one of the most difficult problems to solve. One may understand this by considering the possibilities which exist for re-entrainment of the collected particles which are necessarily exposed to the gas stream, and from major disturbances and dust clouding effects in the hoppers due to large masses of dust falling during rapping periods.

Many schemes have been employed for alleviating or solving the rapping problem. These include various pocket or hollow collecting electrodes, closing dampers during rapping, and many others. In general, such expedients have a very limited effect and have been only partially effective in preventing extra loss during the cleaning operation. A satisfactory rapping system must have a high degree of reliability, by maintaining uniform and closely-controlled

continued on page 117

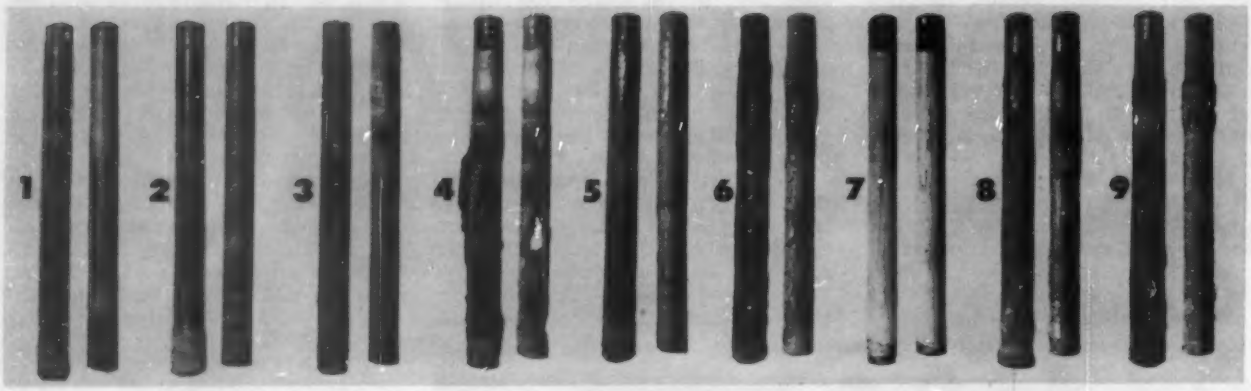


Fig. 1. Coated samples after testing in salt crock equipment. Numbers next to each pair correspond to the numbers of the samples listed in Table 1. Some current flows were so heavy that holes were burned through the metal of the test pieces

Make Sure Your Underground Metal Coatings Do Their Job

Expensive underground piping systems can be ruined if the protective coating fails to prevent corrosion. Here's a simple and accurate method of checking the performance of various coatings

By L. G. JONES

WITH SO MANY more pipe, cable and metallic structures going underground, the story of paint testing would not be complete without a section on this branch of corrosion protection. Most power plants are subject to stray ground currents, and galvanic corrosion can quickly destroy underground metals.

This article is primarily concerned with preventing electrochemical attack on metallic structures buried in average soils. The early gas and today's water systems have been constructed of heavy cast iron pipe. These thick walled mains have resisted corrosion for over a half century. Newer gas lines, most industrial water piping, some conduit and service connections are made of steel sections, that are more susceptible to galvanic and chemical corrosion. Tables II, III and IV illustrate some phases of steel water main corrosion.

These three tables merely emphasize the wide variation in corrosion effects in any study of underground conditions. Many industrial plants are built on cinder, slag or plant waste fills. These waste materials may contain sulphur or other acid forming ingredients with which ground moisture accelerates normal metal corrosion losses.

The most rapid loss of metal is caused by pitting. Pitting is serious because a pipe will pinhole and leak gas or water in a very short time. A faulty spot can render a whole pipe line or cable useless.

Several methods of controlling underground structure corrosion have been developed:

1. Selecting rights-of-way in soils that give minimum electrolytic or chemical action.

2. Coating the pipe or materials with protective non-conducting films or wrappings.

3. Forcing current to flow onto the pipe either through its full length or to neutralize the current flowing off the metal surface in positive or anodic areas.

Only the second or coating method will be discussed, under the category of paints. It is, incidentally, the most easily applied and the most widely used means of protection.

Many insulating coatings or barriers are used today, such as asphalt, coal tar derivatives, plastic tapes, hot enamels, built up wrappings, etc. Coal tar base coatings are probably the most widely used. They have permanence, continuity, hardness, adhesion, electrical and corrosion resistance, particularly in the hot enamels. These resist the action and movement of soils. Their low investment and application costs make them very popular.

After cleaning the metal surface thoroughly, the metallic oxide skin surface must be painted with a primer, usually of coal tar origin which will bond to the pipe and to the coating to be applied to the metal surface. It is standard practice with piping to wrap felt, asbestos or wide glass fiber tape over the coating while still hot or freshly applied. This wrapper strengthens the coating and prevents its rupture during backfill; and also prevents injury or deformation due to soil stresses or movement in settling. Any rupture in the continuous impervious coating permits localized action and pitting.

A good coating [4] must

1. Be waterproof, and resist soil acids and alkalies.

2. Be thick enough to give maximum life and dielectric strength.

3. Maintain good adhesion to the metal surface throughout its life.

4. Not disintegrate with age or by absorption of solvents by the soil.

5. Not be affected by underground temperatures.

6. Be rigid enough to resist breaking or deformation from soil pressures and movements.

7. Retain its dielectric resistance in order to prevent localized galvanic action and pitting.

The cost of the coating is a small proportion of the total cost of the finished line, from 4.8 per cent for 1¼ in. pipe to 3.15 per cent for 16 in. pipe. The cost of reconditioning a line is about 3 times the cost of coating. A good protective coating provides reasonable insurance against the destruction of large investments in underground structures. A coating that fails to protect at a few points may cause deeper pits and shorter life than would have occurred with completely uncoated pipe in the same location.

It therefore becomes good practice to test applied coatings for leaks or pinholes. These are frequently discovered in freshly applied coatings in faulty work. A small, high voltage, low amperage generator with a light steel chain or spring or metal

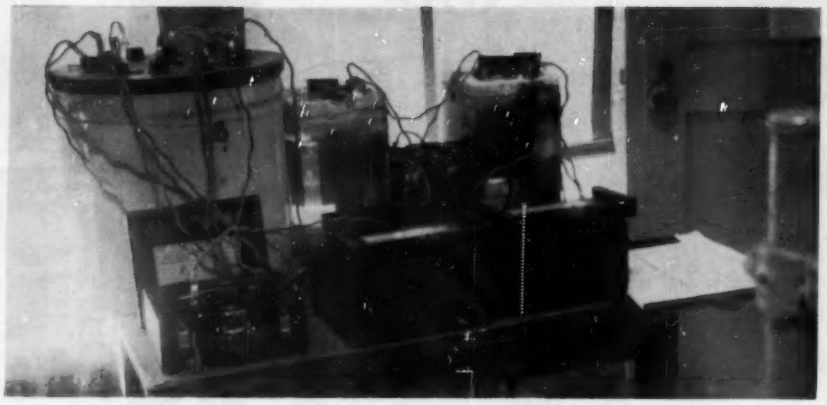


Fig. 2. Salt crock, instruments and batteries for test take up very little room

Table I. Current flow through coatings on pipe samples in salt crock tests[1]

Pipe No.	Code Name	Hot or Cold	Thickness of Coat 0.001 in.	Days exposure to saturated salt solution: 1	10	20	30	40	50	60	70	80	90	Exposed area sq. in.	Per cent of max. area
				Milliamp. current flow, polarized constant readings											
1	PC101	C	9.0	0	2	1.2	1.3	3.5	4.5	7.3	21.7	30	48.4	0.42	1.5
2	RCA50	C	5.5	80	37.5	390	570	790	1280	2880	3130	3800	3800	27.27	100
3	BCA50	C	9.5	114	37	45	63	78	126	228	395	600	1314	9.44	34.6
4	PCT	C	10.0	720	780	590	790	1000	1060	2620	3250	3500	3800	27.27	100
5	BIC	C	6.5	185	220	305	710	1180	2920	3200	3630	3720	3800	27.27	100
6	OBCC	C	2.0	53	270	550	700	726	1280	2370	2850	3150	3350	24.06	88.2
7	BSC	C	22.0	515	705	560	680	1090	1160	2450	2710	2850	2928	21.03	77.1
8	BHE	H	48.5	0	0	0	0	3	11.6	70.2	88.2	105	116.8	0.84	3.0
9	RHE	H	43.0	0	0	0	0	0	0.37	0.88	0	0	0	0	0
	Bare Steel		—	3800	3800	3800	3800	3800	3800	3800	3800	3800	3800	27.27	100

All readings were adjusted to the bare steel rate of 3800 milliamp.
No. 10, BBGT was a green plastic-cloth tape, half lapped around pipe nipple.

brush passed around the outside of the coated pipe will sound an alarm when a pinhole in the $\frac{3}{32}$ in. thick coating is met. Where coating has been expensive, testing for pinholes pays off. Jeep spark coil testers with voltage gap jumps up to 30,000 volts are inexpensive and widely used.

A method of testing coatings used by the author is known as the "salt crock test." The test is carried out in a 5 gal glazed earthenware crock covered with a wooden lid. This lid had a circle of 10 holes into which $\frac{3}{4}$ in. pipe nipples 12 in. long hung suspended in a saturated salt (NaCl) solution. A center hole contained a similar bare pipe nipple. The submerged ends of the pipes were welded closed and the outside surfaces, all but the protruding top ends, coated with the materials tested. The bare top ends were connected to a multipoint switch, through a milliammeter and 4 dry cells to the center bare pipe for the completion of the 6 volt direct current circuit through the salt solution.

Most testers keep the current flowing continuously throughout the duration of the test. Due to polarization, an accumulation of insulating hydrogen collects on the metal, and the current flow decreased. In our tests, the current was left off until the time of readings, when each turn of the switch produced whatever ampere flow any bare spots would permit. Readings were taken after the polarization became constant and the instrument needle stationary.

One of the pipe nipples in the circle was kept uncoated, with maximum surface exposed to current flow. This reading served as the maximum standard to which varying battery flows were adjusted. The results obtained in one set of tests are shown in Table 4.

An examination of this tabulation almost immediately discloses:

1. The porosity of some coatings when freshly applied, on the first day's readings. From the apparent area amperage, this flow did not come from application imperfections.
2. Different rates of deterioration of the various coatings.
3. Relative value of these coatings, or any coatings that may be tested by this method or in this equipment.

On the basis of 3800 milliamperes current flow from bare pipe to bare pipe with an exposed surface area of 27.27 sq in. submerged, we may assume a current flow of 139.2 milliamperes per sq in. of metal surface unprotected from electrical flow. We might then estimate the extent of breakdown of the coatings in terms of the area of metal exposed, computed from the milliamperes of current flow recorded. These values are calculated for the 90 day exposures. The percentage of bare metal that became exposed at the end of the 90 days was then computed.

While thickness of coating is very important, as illustrated in the hot coatings Nos. 8 and 9, the resistant qualities of the materials and ingredients of the coating really determine the ultimate properties of the coatings.

Simplicity of the equipment is illustrated in Fig. 2 which shows how it can all be carried on a small table in a corner of the test room. Figure 1 shows some pipe nipples that have been given a severe test, where not only has the coating failed but large areas of the steel pipe thickness are eaten completely through.

[1] 42 water service pipe tests in 17 American cities by U. V. Kendall, *Corrosion*, F. N. Speller, p. 378, 379.
[2] *Corrosion*, F. N. Speller, p. 378, 379.
[3] *Corrosion*, F. N. Speller, p. 545.
[4] *Gas Age*, Oct. 6, 1928.

Table II. Shows penetration for several values of water alkalinity or acidity[2]

Ph value of water of submergence		In. per year penetration per cc. oxygen per liter of water
Acid	5.0	0.0400
	5.5	0.0335
	6.0	0.029
	6.5	0.027
	7.0	0.024
Alkaline	7.5	0.023
	8.0	0.0025
	8.5	0.022

Table III. Effect of the type of soil on the corrosion rates of ferrous piping[3]

Years	Average maximum pit depth, mils: Merced silt loam	Susquehanna clay	Muck	Memphis silt loam	Ruston sandy loam
0	0	0	0	0	0
2	48	48	47	45	37
4	88	72	65	52	41
6	119	81	81	57	42
8	150	90	101	59	44
10	—	97	120	61	46
12	—	100	137	62	48

Table IV. Shows how rate of pitting changes with time for steel water piping

Years of exposure	Rate of pitting, in. per year
1	0.054
2	0.031
3	0.019
4	0.011
5	0.009
6	0.008

After 6 years, rate of pitting stabilized at 0.008 in. per year.

Power Engineering handbook

A Power Plant Primer

By A. W. KRAMER

IN PART I of the Power Plant Primer, we discussed the rudiments and some of the refinements of the typical steam power plant (see the December 1954 issue). The steam turbine however, as it was left in that discussion, was still a crude device little better than the fan shown in Fig. 1.

Part II

Of course, it is still merely a diagram — no turbine would ever be built that way. The only step remaining to make this elemental turbine into a commercial machine is to introduce *multiple* nozzles of proper design and change the shape of the inefficient paddles to an efficient blade having curved entrances and exits. Figure 10 is a detailed drawing of the nozzles and blades (they are also called buckets) of a modern turbine, and a cross-section through a turbine showing how the elements are arranged on the shaft.

So now we have a boiler and a turbine connected to an electric generator, as in Fig. 11. Here you see steam from the boiler being fed into the turbine by means of the connecting piping, and after passing through the various stages of the turbine the steam *exhausts* through an opening in the bottom of the turbine. The steam has given up its energy to the turbine rotor and this in turn spins the generator rotor. The generator rotor, remember, is simply a magnet.

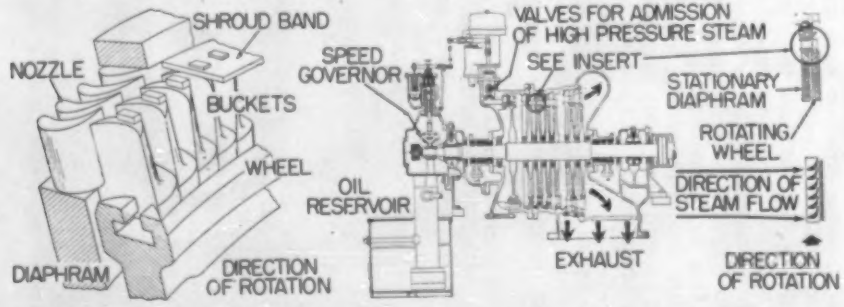


Fig. 10

fold along this line — outside edges toward you

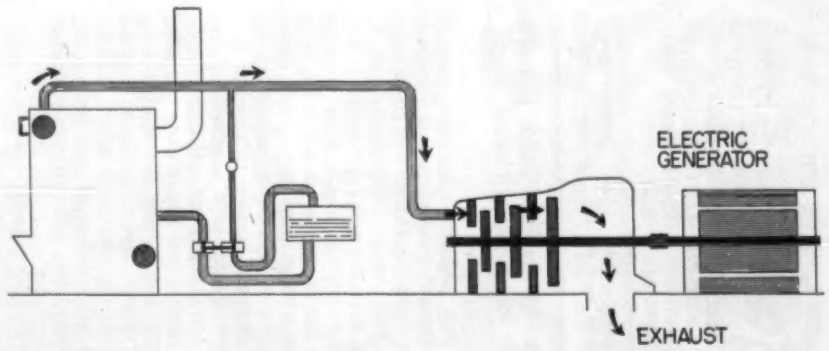


Fig. 11

But what shall we do with the exhaust steam? Is it of any use? Well, if you measure the temperature of the exhaust steam right at the point of the exhaust opening, you will find that it has a temperature of 212 degrees F. This is the temperature of steam at atmospheric pressure.

Obviously, we can use it to heat the water in the feedwater heater in the same way that we used the exhaust steam from the boiler feed pump. However, you would find that there is far more exhaust steam coming from the turbine than you could use in the feedwater heater. Remember, practically the entire boiler output passes through the turbine and out into the exhaust.

If you want to you can pipe this exhaust steam to radiators and use it to heat our houses and buildings in winter (see Fig. 12). Note that part of the exhaust steam in the illustration goes to the feedwater heater. Most of it, however, goes to the building heating system.

Now, this is fine if you have a building you want to heat or if you need steam heat for other purposes such as cooking, heating stills in food or chemical plants or any of scores of different purposes in industry. In practice that is how a great deal of exhaust steam is used. Indeed, this is one of the reasons it pays the owners of an industrial plant, a paper mill for example, or a textile mill or a food products plant, to have their own power plant; they can use practically

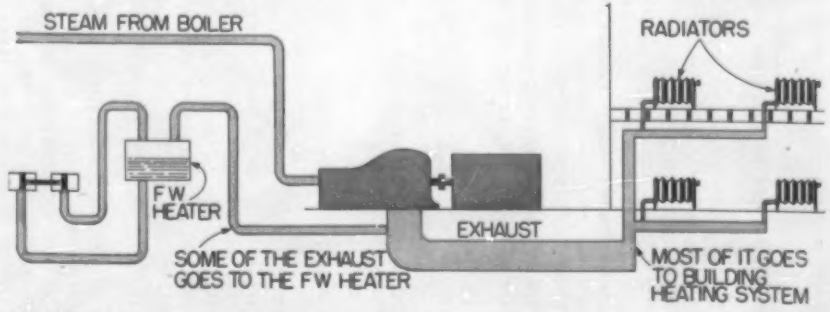

STEAM FROM BOILER
RADIATORS
F W HEATER
EXHAUST
SOME OF THE EXHAUST GOES TO THE F W HEATER
MOST OF IT GOES TO BUILDING HEATING SYSTEM

Fig. 12

cut along this line

January, 1955

Most of the large coal-fired plants today are fired by pulverized coal. The reason for this is that the control of pulverized coal firing is much more flexible than with stoker firing. With stoker firing there is always a bed of coal on the grate which contains a considerable amount of heat. Even if the coal supply were cut off completely, the coal on the grate would continue to burn for an appreciable length of time. With pulverized coal there is no such *reservoir* of heat and if the coal supply is cut off combustion ceases instantly. The same is true of oil or gas.

The use of pulverized coal instead of stokers does not change the basic principle of operation as far as the power plant as a whole is concerned; it merely involves different type of equipment.

Now, what about steam pressure? In one of the foregoing paragraphs we said something about efficiency being related to steam pressure. Is this true?

Yes, but largely because steam pressure is related to temperature. The higher the pressure of steam, the higher its temperature. At atmospheric pressure, that is, 15 lb per sq in. absolute pressure, steam has a temperature of 212 degrees F. At 500 lb per sq in. absolute, the temperature of steam is 449 degrees F.

The efficiency of a turbine, or any other kind of heat engine such as a steam engine or a gas engine, does not depend upon the nature of the working medium — steam, compressed air, ammonia, etc. — but upon the quantity and the absolute temperature of the heat received and the heat rejected. This means merely that a turbine supplied with steam at 400 degrees and exhausting it at 212 degrees is more efficient than one receiving the steam at 300 degrees and exhausting at 212 degrees. Also, a turbine receiving steam at 400 degrees and exhausting at 212 degrees is *less* efficient than one receiving the steam at the same temperature (400) but exhausting it at 100 degrees. This not only explains the value of the condenser but also that of high steam pressure. Without the condenser, the lowest temperature at which steam can be exhausted is 212, since that is the temperature of steam at atmospheric pressure. By means of the condenser, however, a vacuum can be created so that the steam will exhaust at a pressure of, say, 10 pounds *below* atmospheric pressure, that is, at 5 lb per sq in. At 5 lb per sq in. absolute, the steam temperature would be 162 degrees F.

The thing that is important in the operation of a turbine or any other kind of *heat engine*, then, is the temperature *range* through which the heat energy falls in its passage through the engine. The thermal efficiency of the engine depends upon this temperature range. This can be explained very simply by imagining a perfect engine — one in which there are no heat or friction losses of any kind. Of course, such a machine could never be built. Assuming that we had such an engine, however, let us connect it to a source of steam having a temperature of 400 F. Also, assume that the engine exhausts against atmospheric pressure. The exhaust steam then would have a temperature of 212 F.

Now the thermal efficiency of such a perfect engine is easily figured by means of a very simple equation. Here it is:

$$E = \frac{T_1 - T_2}{T_1} \times 100$$

In this expression, E stands for efficiency in per cent, T_1 is the absolute temperature of the steam entering the engine, and T_2 is the absolute temperature of the steam leaving the engine. So, with 400 deg F (860 Absolute)* for the entering steam and 212 deg for the exhaust, the efficiency of this *theoretical* engine is:

$$100 \times \frac{860 - 672}{860} = \frac{188}{860} = 21.8 \text{ per cent}$$

Instead of letting the steam from this engine exhaust against atmospheric pressure, suppose we attach a condenser to the exhaust opening so as to produce a back pressure of, say, 5 lb per sq in. As explained previously, at this pressure, the temperature of steam is 162 F (162 + 460 = 622 Abs). Now the equation will give us an efficiency of

$$100 \times \frac{860 - 622}{860} = \frac{287}{860} = 33.4 \text{ per cent}$$

So, by the addition of the condenser, we have raised the efficiency of the engine from 21.8 to 33.4 per cent.

This simple example, then, shows why power engineers have been striving, not only for higher and higher steam temperatures, but also for lower exhaust temperatures. The greater the range between

*Temp. Absolute = Temp. F + 460. Absolute zero is 460 degrees below zero F.

fold along this line — outside edges away from you

all of the exhaust steam from the turbine for heating purposes.

If they did not have the turbine, they still would need a boiler to generate steam. By first running the steam through a turbine they can get the electric power so produced virtually for nothing.

Suppose, however, there is no building to be heated or no factory process to use up the exhaust steam; what then? Take a public utility plant for example. A public utility plant is designed solely to generate electricity to sell. Such plants usually are far away from buildings where the exhaust steam might be used for heating. Shall the exhaust steam be permitted to be wasted to the atmosphere?

No. There is a much better way of disposing of this exhaust steam. That is by using it to create a vacuum at the exhaust end of the turbine.

A vacuum? Why a vacuum? What good would that do? Well, remember that the turbine is surrounded on all sides by the atmosphere which, at sea level, exerts a pressure of about 15 lb per square inch. In order to get out of the exhaust opening, the steam has to push against this 15 lb per square inch pressure, and this requires work, just as it does to push the turbine blades around. But suppose, by some means, we could remove the atmosphere from around the exhaust opening so that the steam issuing from the exhaust opening would encounter no resistance whatever; you would find that you could develop more power in the turbine, indeed, it would be equivalent to an increase in steam pressure.

To understand how we can accomplish this (removal of the atmospheric pressure) it is necessary to know a few facts about steam. Steam, remember, is evaporated water. When water is heated to a temperature of 212 degrees F at atmospheric pressure it turns into steam. If the water is enclosed in a tightly closed vessel such as a boiler the temperature at which the water turns into steam will be higher. In any case, the volume of the steam produced will be very much larger than the volume of the water from which it was produced. At atmospheric pressure, for example, a pound of steam occupies a volume of 26 cubic feet.

Suppose, now, that you had a pound of steam at atmospheric pressure in a closed vessel with a volume of exactly 26 cubic feet. This vessel would be a trifle less than 3 feet on a side — assuming it to be a cube. It would be full of steam. There would be no air. If you suddenly placed this vessel on a large block of ice, or cooled it by spraying cold water on it, what would happen? The steam would condense — it would turn back into water — into one pound of water. This pound of water, however, would occupy only 1/60th of a cubic foot. It would look about like Fig. 13.

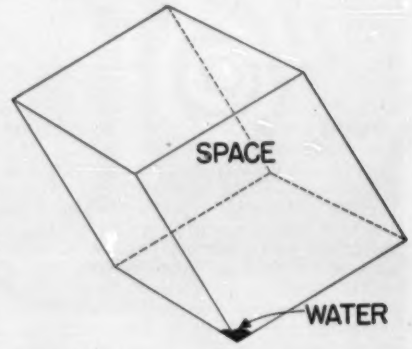


Fig. 13

This is very little water. Most of the interior is now occupied by *nothing* — 99.93 per cent of the total volume. This means a *vacuum*.

The total surface of this cube has an area of 46,650 square inches. Since each square inch has 15 lb of atmosphere pressing down on it (and with nothing inside to counteract it) the total atmospheric pressure on the cube is now 46,650 x 15 or about 690,000 lb.

If you want to see whether this is really true, try it sometime. Take an ordinary rectangular gallon can with a screw cap closure, as in Fig. 14. Fill it with about half inch of water, and bring the water to a boil by placing it on a gas burner for a few minutes. *Do this with the screw cap off.* Then, when the water is boiling vigorously, suddenly screw the cap on, and then quickly place the can under a stream of cold water. The can will crumple up like so much paper. This spectacular experiment is one which anybody can make at home but it is extremely convincing in demon-

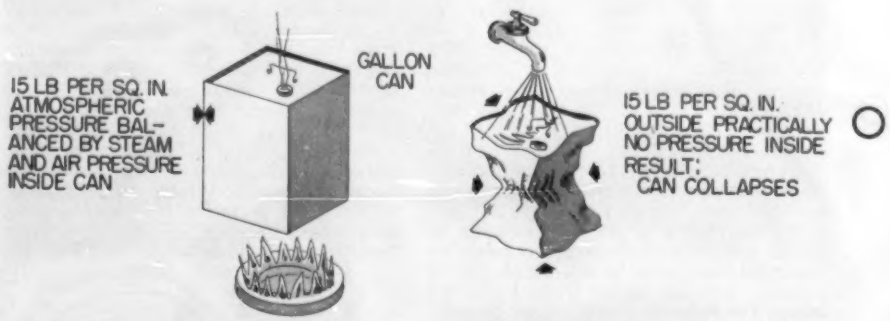

15 LB PER SQ. IN. ATMOSPHERIC PRESSURE BALANCED BY STEAM AND AIR PRESSURE INSIDE CAN
GALLON CAN
15 LB PER SQ. IN. OUTSIDE PRACTICALLY NO PRESSURE INSIDE RESULT; CAN COLLAPSES

Fig. 14

strating the production of a vacuum by the condensation of steam.

Now remember, we wanted to create a vacuum at the exhaust end of the turbine. Now that we know how to create a vacuum, just how can we apply the principle to our turbine? Well, suppose we attach a large hollow vessel to the exhaust opening of the turbine and install a bank of small tubes in the vessel through which we can pump cold water, as in Fig. 15. With such an arrangement, the steam issuing from the turbine will come in contact with the cold tubes and thereby turn back into

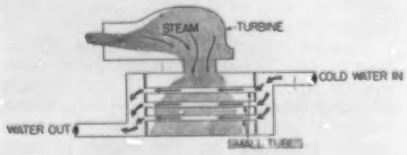


Fig. 15

water. This will create a vacuum in the vessel just as it did in the case of the gallon can. The vessel now, however, is made of heavy steel, capable of withstanding the pressure of the atmosphere, and will not collapse.

Since cold water continues to flow through the tubes, the process is a continuous one. There will be a steady conversion of steam into water, and a steady state of vacuum will exist inside the vessel.

Technically, such a vessel is called a condenser. Its purpose is twofold; first, to create a vacuum at the turbine exhaust, and second, to recover the *condensate* (the condensed steam) so that it can be used over again in the boiler. Since this condensate is really distilled water, it is very pure and highly desirable for use as boiler feedwater.

So, we build another smaller chamber at the bottom of the condenser to provide a place where the condensate can collect and from which it can be pumped back to the boiler, or rather, first to the boiler feedwater heater. This reservoir is called the hotwell since the water which collects in it is fairly warm. Now, our system looks like Fig. 16.

Steam produced in the boiler flows through the main steam header to the turbine. In the turbine it passes, successively, through the various stages, losing pressure at each stage and giving up its energy to the blades on the rotor. This turns the electric generator and produces electricity. Emerging from the exhaust opening at the bottom of the turbine, the steam enters the condenser where it condenses on the tubes through which the cool *circulating* water flows.

Condensation of the steam creates a vacuum which reduces the back pressure which otherwise would impede the flow of steam to a considerable extent. The condensed steam collects in the hotwell of the condenser and is drawn off by the condensate pump which pumps the water into the feedwater heater. Here the water is further heated by the exhaust steam from the boiler feed pump (or other steam driven auxiliaries) and

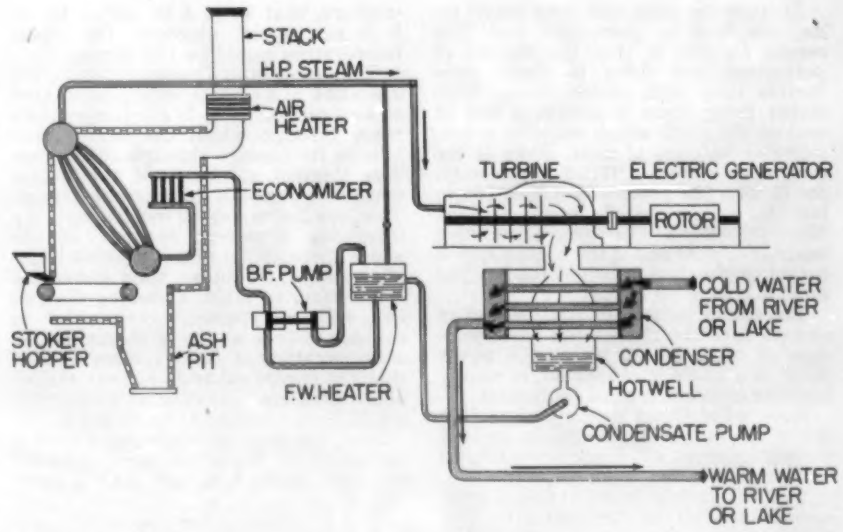


Fig. 16

then is pumped back into the boiler by the boiler feed pump. The latter, it will be noted, is run by steam from the main high pressure header. We now have a completely closed system. All the water that is turned into steam in the boiler is condensed back into water in the condenser and pumped back into the boiler again. Of course, there are slight losses at various points in the system, leakage through pump bearings, steam leakage through valve packing, etc. To make up for this loss a small quantity of *raw* water has to be pumped into the system. This is known as make-up water or simply *make-up*. The idea is to keep the amount of *make-up* as low as possible.

If you are interested only in the basic principle of a power plant, this is all you need to know. True, many more refinements can be added which will further improve the efficiency but the system shown in the last diagram would work, and its efficiency would not be too low depending upon the value of the steam pressure used.

If this explanation, so far, has made sense to you and if it has been of interest, maybe you would like to go a little further and learn something about actual plants as they are built today.

The boiler plant shown in the diagrams is fired by a chain-grate stoker. Most people are reasonably familiar with a stoker because many household furnaces burning coal have stokers. Power plant boilers are also fired by oil or pulverized coal. Where pulverized coal is used, the coal is first passed through a pulverizer which grinds the coal to the consistency of flour and then, by means of a fan, the powdered coal is blown into the furnace where it burns very much as a gas flame. A simple diagram is shown in Fig. 17.

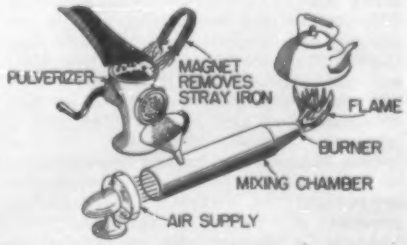
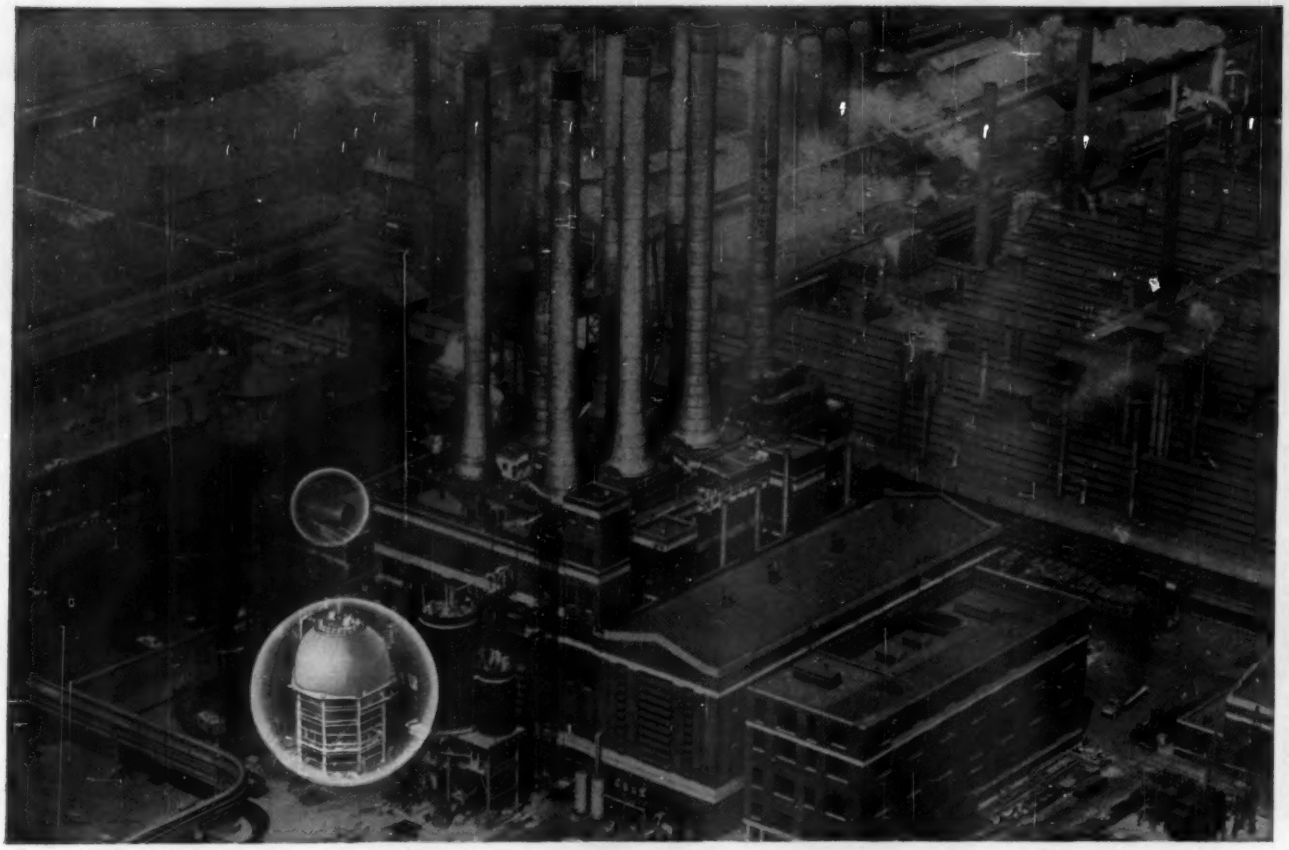


Fig. 17



FORD RIVER ROUGE POWER PLANT

modernizes water system with

Cochrane HOT LIME ZEOLITE

A Cochrane 200,000 gph Hot Lime Zeolite System answers the treated water requirements of higher quality and increased capacity at the world-famous Ford River Rouge Power Plant . . . and at an estimated savings of $49,000.00 a year in operating cost!

The Kuljian Corporation, consulting engineers, in collaboration with Ford engineers, have assured adequate feedwater supply for the boilers. Ample supply is also available for future high pressure boilers even though the service may require 100% makeup water.

The system consists of one of the world's largest single unit, Sphericalhead design, hot lime softeners to reduce alkalinity to 25 ppm, a battery of pressure filters to remove turbidity, and hot zeolite softeners to produce an effluent practically free from hardness.

To provide oxygen free feedwater, a Cochrane deaerating heater with a capacity of 1,500,000 lbs./hr. follows this Hot Lime Zeolite plant.

Cochrane is the pioneer and largest manufacturer of hot process softeners and deaerating heaters. Hundreds of early hot process installations have been converted to Hot Lime Zeolite by Cochrane, with resultant high quality water such as that required by Ford's River Rouge Plant.

If your problem is a new installation or the conversion of an old plant, our engineering background in water conditioning will provide the most economical method to meet your requirements. Why not contact Cochrane today?

Cochrane

CORPORATION

3132 N. 17th STREET, PHILADELPHIA 32, PA.

NEW YORK • PHILADELPHIA • CHICAGO

Representatives in 30 principal cities in U. S.; Toronto, Canada; Mexico City, Mexico; Paris, France; Havana, Cuba; Caracas, Venezuela; San Juan, Puerto Rico; Honolulu, Hawaii.

Pottstown Metal Products Division—Custom built carbon steel and alloy products

COCHRANE CORPORATION
3132 NO. 17TH ST., PHILA. 32, PA.

Send me a copy of Publication Nos. 4801, 5800, 3005, 4643, 5001-A, Reprints of Technical Articles. (Circle publication desired).

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Demineralizers • Hot Process Softeners • Hot Zeolite Softeners • Dealkalizers • Reactors • Deaerators • Continuous Blow-Off • C-B Systems • Specialties

For more data circle 533 on Post Card

the temperature of the steam entering and leaving the turbine, the higher will be the efficiency of the turbine.

Of course, there is no such thing as a perfect heat engine and in practice the efficiencies obtained are much lower than those considered in this example, but the principle involved is essentially the same. It should be perfectly clear also that when a condenser is added to a system, it becomes necessary to pump large quantities of cooling water through it, and also, the condensate has to be pumped out of the condenser. This requires power and this added power has to be subtracted from that developed by the turbine when the efficiency of the system as a whole is considered. We do not get anything for nothing in this world.

And this is as it should be; it makes the power engineer's job interesting regardless of which branch of the field he may specialize in. Take this quest for the attainment of higher steam temperatures and lower exhaust temperatures for example. This has led the power engineer into all sorts of complex things involving chemistry, physics, metallurgy, techniques of manufacture and construction, and, of course as always, economics. High steam temperatures and pressures together with systems of higher and higher capacity make necessary alloy steels capable of withstanding the high temperatures and pressures; high rates of evaporation in boilers together with high pressures and temperatures make necessary elaborate feedwater treating systems involving constant, close chemical control; high pressures and temperatures also affect the character of the piping arrangements, valves, fittings, methods of insulation as well as many other things.

With the use of high pressures and temperatures the simple method of heating the feedwater by exhaust steam from the boiler feed pump or other steam driven auxiliaries shown in the last version of our system (Fig. 16) will no longer suffice because the feedwater must be heated to a far higher temperature before it enters the boilers. Modern boilers operating at steam pressures of 1000 lb per sq in. have water temperatures of around 556 F. It is obvious that the feedwater will have to be somewhere near that temperature if severe strains are to be avoided.

So we have the problem of increasing the feedwater temperature. Just how are we going to do it? What is the best way of doing it? Of course, one way of doing it would be to use high-pressure, high-temperature live steam from the main header and feed it into a special feedwater heater capable of withstanding the high pressure. This, however, would be wasteful. The steam in the main header is the most valuable commodity we have in the system, and every pound of it should be delivered to the main turbine where it can do the most good.

Another method would be to supply the heat required for feedwater heating from a separately fired water heater but this would be even less efficient than taking live steam from the boiler itself.

Suppose, however, that feedwater is heated by steam extracted from an intermediate stage of the main turbine; then power will be developed by the steam used for feedwater heating. Moreover, this additional power generated by the extracted steam will be produced at a very high efficiency and this, in turn, will increase the average efficiency at which the total power output of the system is generated.

Now, why is this so? Why does this extracted steam produce power at a much lower fuel cost than that of power produced by steam flowing to the condenser? The answer to this question lies deep in thermodynamic theory but for practical purposes it can be explained as follows. In even the best modern condensing turbine power plants, approximately two-thirds of the heat present in the steam at the turbine inlet is left in the steam at the exhaust. Even if it were possible to have a 100 per cent efficient turbine, the amount of heat thrown away at the exhaust would not be greatly reduced. Actually, this heat is carried away by the cooling water flowing through the condenser.

This means, then, that even at best, only about one-third of the heat in the fuel can be turned into power. If, however, we extract a portion of the steam from the turbine before it reaches the condenser, and use it to heat the feedwater, none of the heat in this steam will be wasted because it will all be absorbed in the boiler feedwater. Thus it decreases, heat unit for heat unit, the heat required by the boiler.

Putting it another way; of the steam flowing from the throttle to the condenser, about two-thirds of the heat will be thrown away, while of the steam flowing from the throttle to an extraction opening, no heat will be wasted. It follows directly, then, that the more power that can be generated by extracted steam, the higher will be the average plant efficiency. Of course, the amount of steam which can be used for feedwater heating is determined by the amount of heat needed to raise the temperature of the boiler feedwater to the required level. This places an upper limit on the gain in efficiency which can be made in this way.

As in the previous diagrams, steam from the boiler enters the turbine and flows through the turbine stages, generating power. Most of the steam passes through the entire turbine and exhausts into the condenser. A part of the steam, however, is extracted from an intermediate stage of the turbine at a pressure and temperature higher than that at the exhaust. We can take advantage of this scheme as shown in Fig. 18.

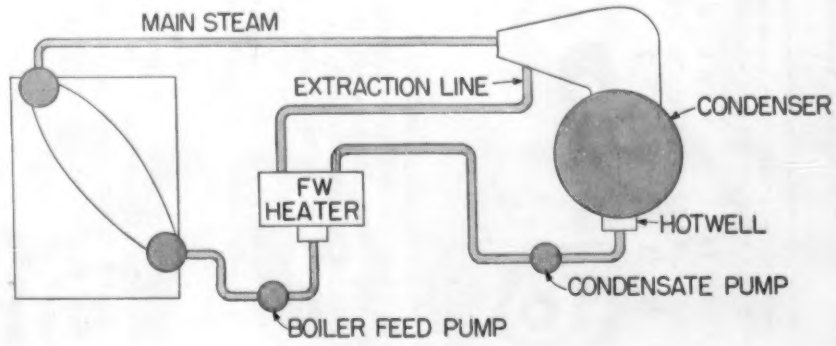


Fig. 18

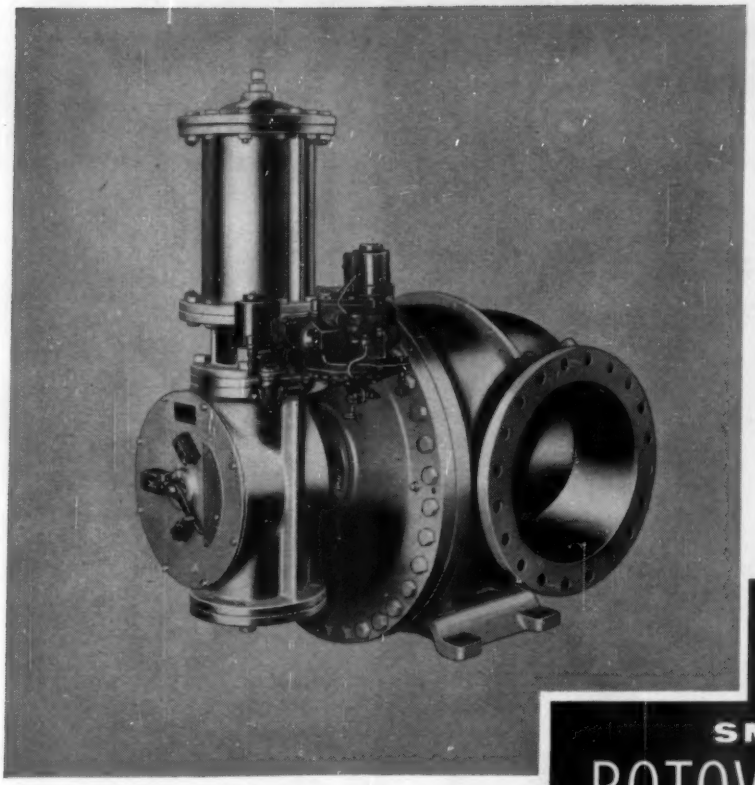
In order that the temperature of the feedwater be high enough, it is necessary in this case to extract the steam at a point in the turbine where the temperature is somewhere in the neighborhood of the temperature of the water in the boiler. This, of course, limits the amount of power that can be obtained from this extracted steam. It would be better if the extraction point could be located closer to the exhaust end of the turbine for maximum power development.

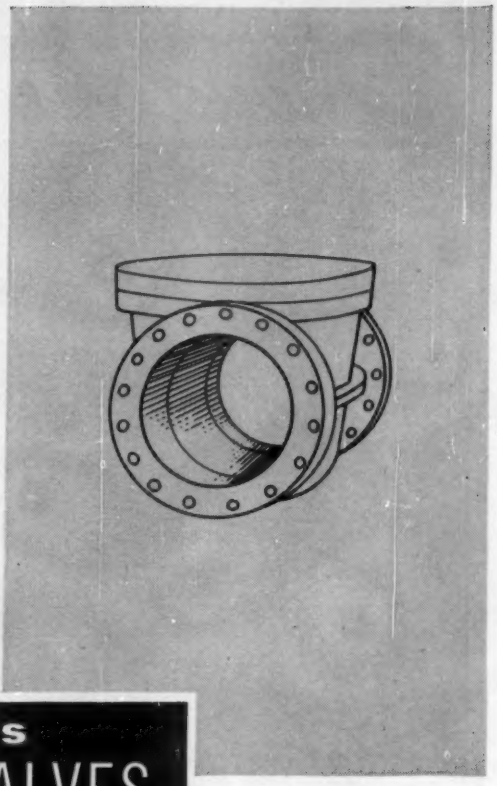
(Part III will appear in next issue.)

NOTICE

Are you saving these pages of the POWER ENGINEERING Handbook? They are designed to help you with the problems of training new men in the operation and maintenance of power plants, and also to stimulate the thinking of more experienced men. While they last, extra copies of the Handbook pages may be obtained each month by writing the editors.

The entire Power Plant Primer has been prepared as an 8½- by 11-inch booklet for $1.00 per copy. Extra copies of the Primer as it appears in the POWER ENGINEERING Handbook are available free while they last.





SMS
ROTOVALVES

LESS HEAD LOSS
MEANS LOWER PUMPING COSTS

Free, unobstructed flow through SMS-Rotovalves means a lower head or pressure loss, helps you keep pumping costs down. The full line opening shown in the drawing above offers no more resistance than a straight piece of pipe of the same diameter.

Rotovalve design solves many control problems. The conical plug first lifts, then rotates and finally reseats. You get easy operation, precise aperture control, controlled closing time, tight and positive closing, easy mechanical cleaning, low maintenance, long life.

These high-performance characteristics are the result of over 75 years of engineering and research experience in the hydraulics field. For detailed information on Rotovalves, contact our local representative or write to the S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines
Pumps
Gates & Hoists
Trash Rakes
Accessories

HYDRODYNAMICS

Rotovalves
Ball Valves
Butterfly Valves
Free-Discharge Valves
Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

SMS

For more data circle 539 on Post Card

Downtime?

What's the Price Tag on Yours?

You can't get away from downtime—
BUT you can reduce its frequency.

For instance, how much less downtime would you have if the cylinder liners in your diesels were more resistant to wear?

No cylinder liner is wearproof — BUT liners with PORUS-KROME plated bores will last *three* to *five* times longer than raw cast iron liners — AND engines with PORUS-KROME liners use *less* lube oil.

Specify PORUS-KROME liners for your next diesel, or reclaim worn liners with PORUS-KROME.

In either case you will be sure to have less downtime and more economy.

Write for a copy of "on PORUS-KROME", a twelve page illustrated brochure that describes the PORUS-KROME process.

Address -
Dept. PO-1, VAN DER HORST CORP., OLEAN, N. Y.

*PORUS - KROME

Good for the Life of your Engines

VAN DER HORST

TERRELL, TEXAS
OLEAN, NEW YORK
LOS ANGELES, CALIFORNIA**
HILVERSUM, HOLLAND

*U. S. Patents
2,048,578. 2,314,604. 2,412,698

**SparTan Engineering
West Coast Licensee

For more data circle 538 on Post Card

Hydrogen Purging

continued from page 73

Normally, the generator name plate will indicate the cubic foot content of the housing in cubic feet. Divide this by 8.5 cu ft, the volume of 1 lb CO_2 at atmospheric pressure and 70 F temperature. To this result add 50 per cent, and you get the total number of pounds of CO_2 required for the operation. Thus, for example, a generator housing of 1700 cu-ft-size would require 300 lb of CO_2, or six standard cylinders.

With the 12 kw vaporizer, a thermostat limits the temperature rise to 170 F, so that a basic operating rate of delivering 300 lb of carbon dioxide per hour, at 100 F, is maintained.

The schematic piping diagrams shown in Figs. 1, 2, and 3 show the relationship of CO_2 cylinders, vaporizer, pressure reducing valve, and generator housing. In operation, all cylinder valves are first closed. Valve "C," the pressure reducing valve, is opened fully. The vaporizer is then turned on and allowed to come up to full heat. The pressure reducing valve is then closed, and all cylinder valves opened fully.

When the operator is ready to let carbon dioxide into the housing, valve "C" is opened to a point so that the line leading from valve "C" is warm (100 F). Then the vaporizer is working at full capacity. Should freezing occur between the cylinders and the vaporizer, simply reduce the opening of valve "C". For maximum operating capacity of the system, the line from the vaporizer to valve "C" should be kept warm at all times. This is controlled by valve "C".

To sum up, a practical system for purging hydrogen from generator housings should be capable of meeting the following five requirements:

1. Cylinder discharge manifolding should be so designed that the total number of CO_2 cylinders required to complete the purging operation can be connected before purging begins, thus avoiding the necessity of changing cylinders during the operation.
2. Carbon dioxide should be removed from cylinders or dry ice converters in liquid form to avoid removing it in the gaseous state.
3. Sufficient heat should be added to the liquid CO_2 to change it to a warm gas at a temperature not only sufficient to insure its arrival in the housing as a gas, but with a temperature sufficiently high to make possible the use of an efficient and economical quantity of the gas itself.
4. The heat that is added should be dry electric heat to eliminate the possibility of frozen lines, traps, valves, or other equipment.
5. Finally, dry electric heat should be used because it is probably the most economical, most easily installed, and most easily operated form of heat to use in electric generating installations.

New Conveyor Belt Combines Increased Strength With Extra Flexibility

Rugged Mainliner - Conveyking conveyor belt is engineered for tough jobs involving high tensions, high lifts and long center distances. It's ideal for conveying coal, ores and aggregates. It's steel-like in strength, practically stretchless, yet extremely flexible and troughs easily.

Mainliner belts have about twice the strength of ordinary cotton duck belts of the same gauge. They resist the destructive action of water, oil, weather and age. Why? Because these belts are made of multiple plies of strong duck with Nylon woven across the width and a new-process, high-strength cotton woven lengthwise, with skim coats between plies. They are available in any lengths, with any number of plies, in widths up to 72".

Like other heavy duty belts, these Mainliner Conveyking belts are custom made to meet particular requirements of individual jobs. They can be made with a cover tensile strength of 3500 to 4000 pounds average and a friction pull of 20 to 24 pounds average. They can also be made with a cover tensile strength of 2500 to 3000 pounds and a friction pull of 16 to 19 pounds. They are also available in oil-resistant Neoprene. All are mildew inhibited throughout. A breaker strip can be included in top cover, if specified.

We also manufacture a complete line of industrial rubber products: hose, belting, packing and moulded rubber of every construction for every need. *Through your Quaker and Quaker Pioneer distributor* our research and engineering services are always available to help you solve any industrial rubber problem. *Write for free folder and name of distributor.*

QUAKER RUBBER CORPORATION
Philadelphia 24, Pennsylvania

HKP
H. K. PORTER COMPANY INC. OF PITTSBURGH

QUAKER PIONEER RUBBER MILLS
San Francisco 7, California

For more data circle 534 on Post Card

LATTICE BRAID* Packing

helps protect valuable plants at The New York Botanical Garden

*Registered Trademark. *Only* Garlock makes LATTICE BRAID rod and shaft packings.

Continuous steam heat service is essential during the winter months at The New York Botanical Garden. Any breakdown could cause the loss of many valuable plants. That's why R. E. Wills, Chief Engineer at the Botanical Garden is now using LATTICE BRAID Packing on all expansion joints handling the steam. On this service LATTICE BRAID lasts *two to three years* with no leaks or breakdown. *And* it remains soft and pliable at all times. The best service from previous packings was six to twelve *months*.

Put Garlock LATTICE BRAID Packing to work for your company. All the braided strands of this unique packing are lattice linked together into one structural unit. The strands hold together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

LATTICE BRAID is made from flax, cotton, asbestos, wire-inserted asbestos, Teflon, and asbestos with Teflon impregnation—for various types of services.

Get all the facts about LATTICE BRAID *Packings. Contact your Garlock representative or write for new folder AD-131.*

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N. Y.) • Philadelphia Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK LATTICE BRAID PACKING

For more data circle 540 on Post Card

Motor Enclosures

continued from page 75

lating air must be circulated through the motor by an external fan. Such motors usually have a 40 C temperature rise so that they have a service factor.

Enclosed With Self-Ventilation: If the motor must circulate its own ventilating air, it is said to be self-ventilated, and will not only circulate the air through its own ventilating passages, but also through a standardized amount of external pressure drop. If the inlet and discharge openings are in the bottom it is called a base-ventilated motor, as shown in Fig. 5. If the air comes into the motor above the floor level, it is called a pipe-ventilated motor. Both the base-ventilated and pipe-ventilated motor are usually rated 50 C rise and hence do not have a service factor. At additional cost the motor can be given a 40 C rating and will then have a service factor.

Where clean ventilating air is not available, but cooling water and a drain can be provided economically, it is customary to use an enclosed, self-ventilated motor with air cooler. In this enclosure, the cooling air recirculates through the motor and an air cooler. The pressure to circulate the air is provided by fans mounted on the rotor in high-speed motors. At lower speeds, it is necessary to introduce a motor-driven blower to circulate the air, but if this blower is required, it is included in the price of the motor.

Totally-Enclosed, Fan-Cooled: This motor has the most expensive enclosure with the exception of the explosion-proof types. However, it may prove to be the most economical for those locations requiring protection for the motor where no clean cooling air is available and where it is expensive to provide cooling water and a drain.

A small motor is not so difficult to build totally-enclosed because it has a larger surface in proportion to its losses. The losses and the heat to be dissipated are roughly directly proportional to the volume of the active parts of the motor. In order to get an idea of the problems involved in building large T.E.F.C. motors, consider two exactly similar motors except that one is twice the size of the other. The larger motor will have a surface that is four times larger than the surface of the smaller motor, but it will have a volume eight times larger so that the losses will be roughly eight times as high. Thus, if no artificial means is used to increase the cooling surface, it will have twice as much heat to get rid of from each sq in. of surface, and will run at roughly twice the temperature rise of the smaller motor. In order to bring the temperature down, it becomes necessary to

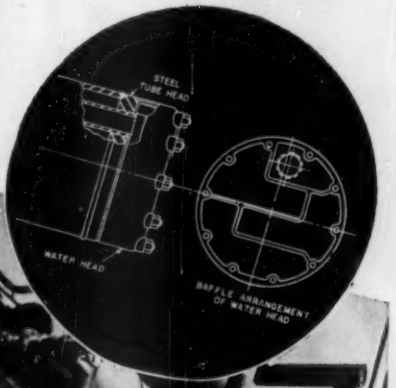
$ave Power and REFRIGERATION COST

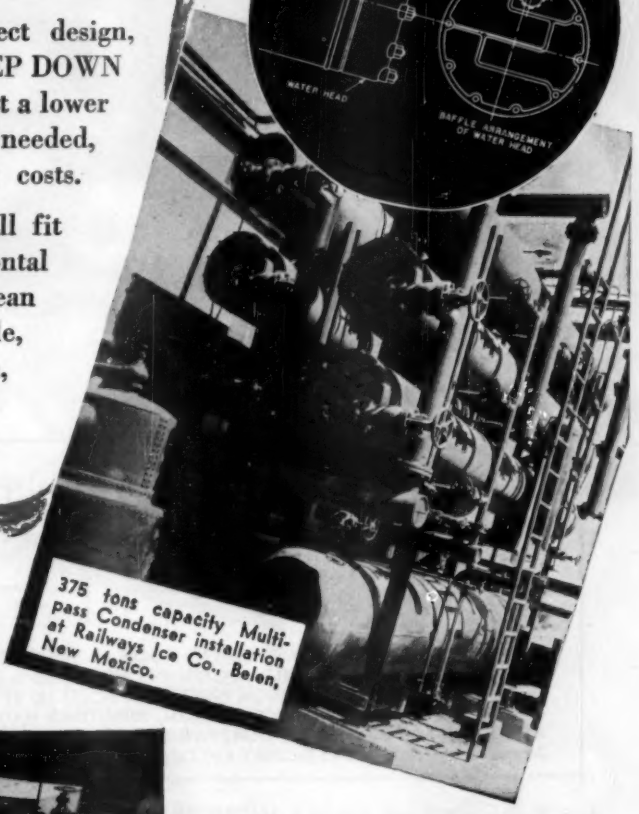
Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

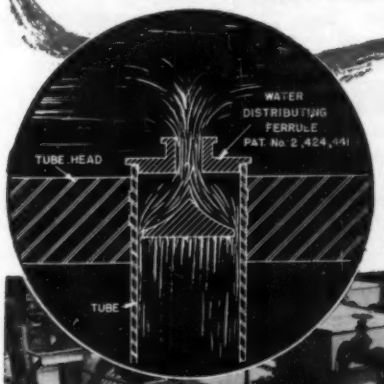
Horizontal Multipass Condensers
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.



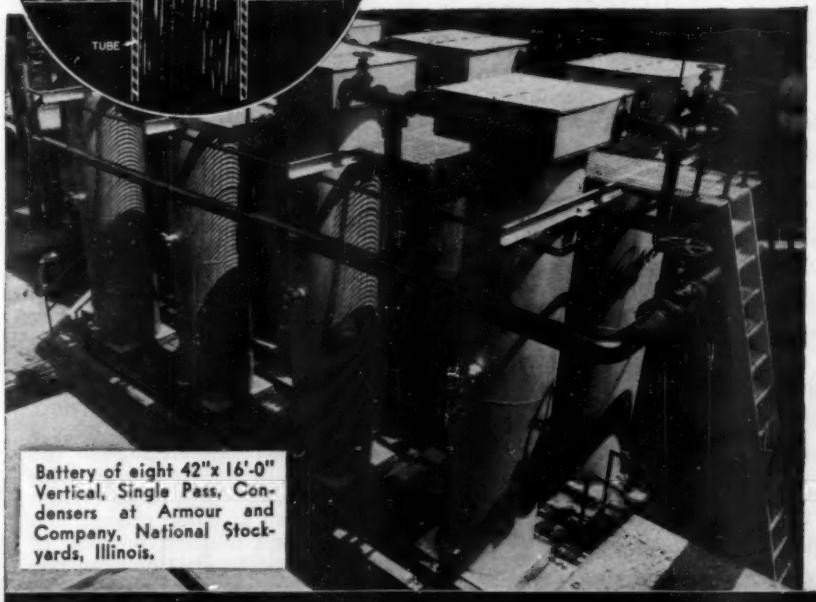


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

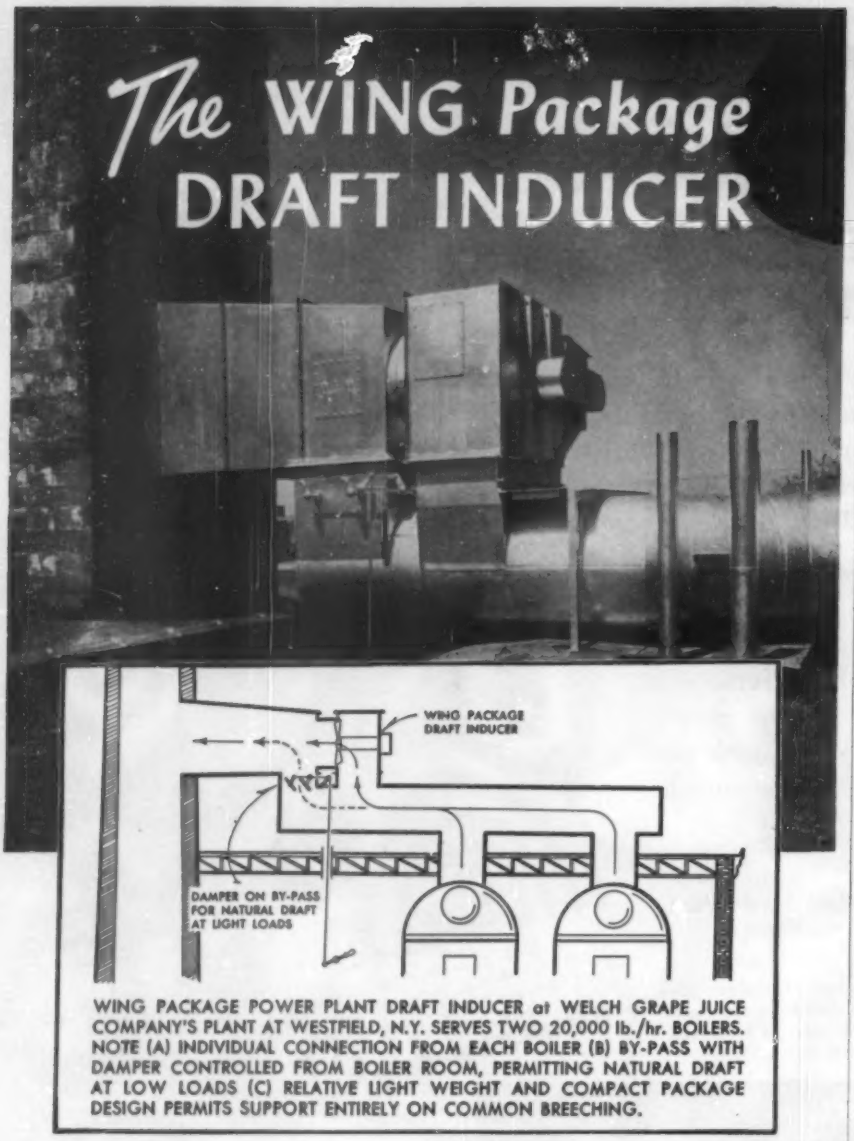
HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

Write For Bulletin RC-2

HENRY VOGT MACHINE COMPANY
INCORPORATED
1000 W. ORMSBY ST., LOUISVILLE 10, KY., U.S.A.
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Vogt REFRIGERATION CONDENSERS

For more data circle 535 on Post Card



WING PACKAGE POWER PLANT DRAFT INDUCER at WELCH GRAPE JUICE COMPANY'S PLANT AT WESTFIELD, N.Y. SERVES TWO 20,000 lb./hr. BOILERS. NOTE (A) INDIVIDUAL CONNECTION FROM EACH BOILER (B) BY-PASS WITH DAMPER CONTROLLED FROM BOILER ROOM, PERMITTING NATURAL DRAFT AT LOW LOADS (C) RELATIVE LIGHT WEIGHT AND COMPACT PACKAGE DESIGN PERMITS SUPPORT ENTIRELY ON COMMON BREECHING.

The WING Package DRAFT INDUCER is unique in that the motor (or turbine) and fan is designed as one complete removable unit, making installation easier and being easily removed, facilitates inspection and maintenance. Other advantages are:

1. Big savings in space requirements
2. Permits fewer and lighter structural supports
3. Eliminates field line-up problems
4. Eliminates water cooling
5. Only two support bearings
6. Wide flexibility in gas outlets
7. Saves on investment and maintenance
8. Low load ratings on natural draft because of ample free gas travel area

Write for complete details

Wing

L. J. Wing Mfg. Co.
64 Vreeland Mills Road
Linden, New Jersey

For more data circle 541 on Post Card

Motor Enclosures

continued from page 96

provide more surface for heat dissipation. This is done by building a large number of tubes into the motor frame to form an air-to-air heat exchanger. The room air or outside air is blown through the inside of the tubes by a fan mounted on the shaft outside the enclosure. The inside air is circulated through the motor by fans mounted on the rotor.

Explosion-Proof Motor: This is a totally-enclosed, fan-cooled motor that has an external casing sufficiently strong to withstand the pressure of an internal explosion and specially constructed flanges and shaft openings to prevent ignition of the atmosphere outside the motor by an internal explosion.

A motor of this type is shown in Fig. 7, while the motor shown in Fig. 6 depends on the blanketing effect of inert gas to prevent any dangerous atmosphere reaching the windings, or any spark or flame from the windings reaching an inflammable atmosphere. With this method of making the motor explosion-resistant, the enclosure can be of lighter construction than the standard type of explosion-proof machine. The gas-cooled motor has automatic equipment to maintain pressure inside the machine above atmospheric pressure, and has pressure relays to warn when internal pressure drops below a safe differential above atmospheric pressure.

Electrostatic Precipitators

continued from page 85

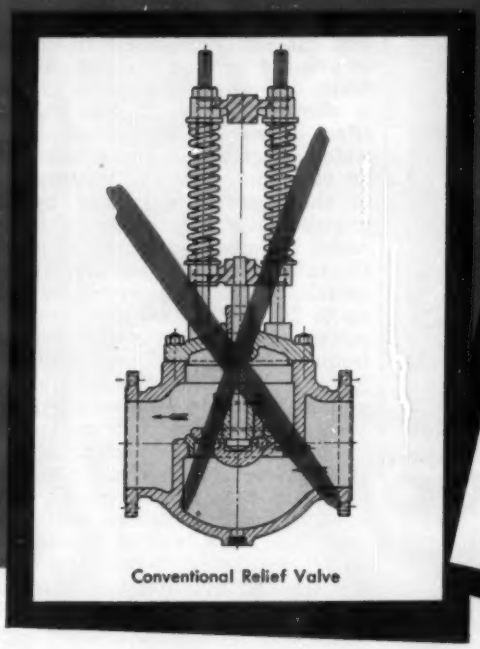
raps over long periods of time, and by flexible and easily-controlled rapping intensity.

With the trend toward higher efficiencies and cleaner stacks, the clouding and puffs associated with intermittent rapping of electrodes have become increasingly objectionable, even though it may be demonstrated that the dust loss during rapping will reduce over-all efficiency by only 2 or 3 per cent, or less. The psychological reaction of the public to such puffs cannot be reversed by technical arguments, and the only satisfactory solution is to eliminate puffs altogether. That is one of the purposes of the magnetic impulse rapper. It converts precipitation from an intermittent or batch process to a continuous and uniform process. In addition, over-all collection efficiency frequently exceeds that possible with intermittent rapping because best electrical conditions are maintained continuously in the precipitation zones.

Most of the rapper systems of the past have been based on mechanical or pneumatic principles and suffer

NOTICE ANYTHING UNUSUAL ABOUT THIS RELIEF VALVE?

ITS NEW FEATURES ARE TYPICAL EXAMPLES OF SK ADVANCED DESIGN



Conventional Relief Valve

NEW SK RELIEF VALVE

Look again . . . at the diagram of the conventional relief valve and the new SK Relief Valve beside it. Note the uncommon features of the SK Valve . . .

. . . Single Spring Construction. This eliminates the cumbersome, unstable superstructure of conventional, multiple-spring relief valves.

. . . Large Coil Diameter and Heavy Spring Wire Cross Section. This provides maximum spring stability; there is the least possible difference between pressure needed to unseat the valve and that required to force it full open.

. . . Valve-Spindle Guides Both Above and Below Valve Disc. These assure accurate seating and permit the use of valve in any position and its installation in vertical or horizontal pipelines.

. . . Reduced Over-all Height Through the Use of Reach Nuts. This eliminates long spring rods and permits the use of rods which do not extend beyond the upper spring plate after compression.

BUT THIS IS NOT ALL!

Right now—while you read this—new products and improvements are taking form on our drafting boards, and others are being third-degree'd in our research and testing laboratories. We call this "Progressive Design" —a job at which we excel because we have the staff, the background, the ability and the facilities to deal with the toughest problems. We invite you to prove this. If a design puzzle has you frustrated, bring it to us. No obligation, of course.

SEND FOR YOUR FREE COPY OF NEW VALVE BULLETIN V-1

It describes, in condensed form, the line of valves made by SK. You'll find it a gold mine of information.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS
2221 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus • Heat Transfer Equipment
Strainers • Condensers and Vacuum Pumps
Oil Burning Equipment • Rotameters
Flow Indicators • Radiafin Tubes • Valves
Spray Nozzles and Atomizers • Gear Pumps
Desuperheaters

For more data circle 537 on Post Card

YOU CAN DECREASE DOWNTIME TREMENDOUSLY

WITH R/M'S BIG 7 PACKING TYPES

R/M's Big 7 Packing Types make it easier for you to schedule downtime —go a long ways towards keeping it from being forced on you. Each of them is engineered to do specific jobs. Between them they can handle all but the very rarest packing applications. Most plants have found that they can meet their needs with just 3 or 4 of these packing types. And because they can, they've been able to cut investment costs, lower inventories, simplify ordering, and reduce errors due to faulty selection. To find out how you can get the same results for your plant, ask your R/M distributor for the R/M Big 7 Recommendation Chart.

R/M's BIG 7 PACKING TYPES MEET 95% OF ALL PACKING NEEDS

R/M Packings for maintenance purposes are sold only through authorized R/M distributors

R/M BIG 7 PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks Clutch Facings • Fan Belts • Radiator Hose • Bowling Balls

For more data circle 543 on Post Card

Electrostatic Precipitators

continued from page 98

from certain inherent limitations and disadvantages, such as inflexibility and inability to stand up under field conditions of moisture, dirt, and corrosive atmosphere.

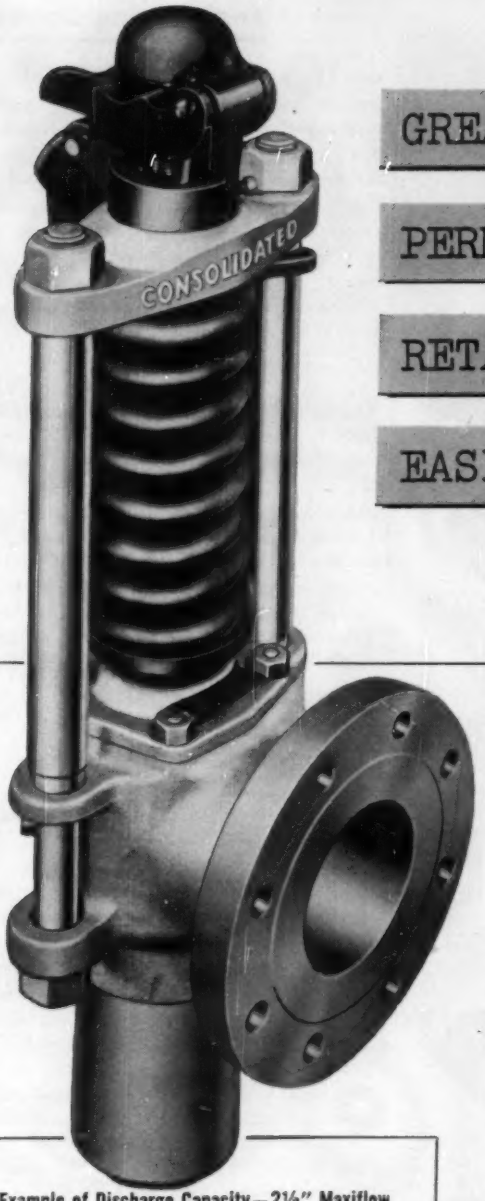
The magnetic impulse rapping system can easily replace conventional or existing rapping systems. A schematic diagram of the new MI rapper is shown in Fig. 3. The rapping effect is provided by a steel plunger which functions as the armature of an electromagnet. The solenoid coil of the magnet is excited by the impulsive discharge of the condenser, which is timed and controlled by the thyratron tube and distributor switch. Any number of rapper units up to 24 may be energized from one power unit. Both the intensity and frequency of rapping are easily adjustable by varying the condenser voltage to meet varied requirements. It may be noted that one of the important practical advantages of this system is that the rapper unit has only one moving part, which is hermetically protected against atmospheric dirt and corrosion and which is lubricated permanently at the time of manufacture. For continuous operation the rapping intensity is usually extremely light, corresponding for example to the blow delivered by a one-pound weight dropping about 1 in. under gravity. With this method of rapping it becomes possible to maintain continuously an essentially clean stack at 98 to 99 per cent efficiency with no trace of puffs or clouding.

NEW ENGINEERING BOOKS

Steam, Air, and Gas Power, by Severns, Degler, and Miles; 502 pages, 8¼ by 5¼ in., cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. Price $6.50.

This is the fifth edition of a well-known textbook on heat-power engineering. In this field, which is constantly changing as new techniques are developed and older methods and equipment are superseded, a textbook must often be revised if it is to keep up to date with all these changes.

In this new edition, the authors have added a great deal of new information to their previous complete coverage of the heat-power field. The chapter on gas turbines has been expanded, and a completely new chapter has been added on mechanical refrigeration. Steam engines have been confined to one chapter, and the treatments of



GREATER DISCHARGE CAPACITY...

PERMANENT TIGHTNESS...

RETAINED POPPING POINT...

EASILY CONTROLLED BLOWDOWN...

CONSOLIDATED *Maxiflow* SAFETY VALVE

sets a new standard in safety and service

Today's high-pressure, high-temperature steam generating plants require safety valves with greater discharge capacity. The Consolidated *Maxiflow* Safety Valve always has it available when needed.

Dependable tightness—month after month—is likewise inherent in the design of Maxiflow. Thermodisc seating equalizes temperature differentials when the valve reseats after blowing—thermal stresses are minimized, distortion is prevented.

Popping point retention is achieved by use of a special alloy steel to stabilize the spring support in the yoke rods—by use of a stainless steel spindle that provides thermal compensation for any elongation of other parts that affect spring loading.

Blowdown control, while the valve is under pressure, requires only a simple external adjustment.

Constant entrance conditions for steam flow are assured by precision-machined forged steel through bushing and inlet. No porous castings to leak.

These are but a few of the performance-proved features that make the Consolidated Maxiflow Safety Valve outstanding in safety and service. Five sizes—1½", 2", 2½", 3", and 4"—make selection easy. Bulletin 707 contains full details, including capacity tables. Write for a copy.

Example of Discharge Capacity—2½" Maxiflow

Gauge Pressure PSI	Capacity Saturated Steam Pounds Per Hour A.S.M.E. Rating
1200	143,700
1500	179,000
2000	238,400
2500	297,600

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* 'HANCOCK' VALVES, *Watertown, Mass.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data circle 536 on Post Card

Yes, Dart Unions fit tighter and last longer because their two bronze seats are precision ground to a true ball joint. You get a drop-tight connection without straining arm, wrench or union. What's more, a Dart uncouples just as easily. Ask your supplier.

QUICK FACTS

- Extra wide bronze seats resist pitting and corrosion.
- Nut and body of air-refined, high test malleable iron are practically unbreakable
- Heavy shoulders can withstand the toughest wrench abuse
- Each Dart is individually vacuum-tested

DART UNION COMPANY
Providence 5, Rhode Island
The Fairbanks Co. Distributors
Boston·New York·Pittsburgh·Rome, Ga.

DART
UNIONS

For more data circle 542 on Post Card

Engineering Books

steam generators, turbines, condensers, pumps, and other auxiliaries have been modernized. The section on air compressors now includes centrifugal and axial flow types, and much information has been added in the chapters on thermodynamics. The book contains new and up-to-date illustrations, a long list of graded problems, and a large number of examples. In addition, all previous material has been revised and brought up to date wherever possible.

★ ★ ★

Residential Wiring Handbook will probably interest the power engineer for his personal use. The Edison Electric Institute, one of the sponsoring organizations, has been authorized by the Industry Committee on Interior Wiring Design to serve as publishers of the new Handbook. Price 25 cents. Quantity prices may also be obtained upon application to the Adequate Wiring Bureau, 155 E. 44th St., N. Y.; the Edison Electric Institute, 420 Lexington Ave., N. Y., or from the headquarters office of any of the sponsoring organizations.

★ ★ ★

Rural Electrification; 2 vol., a report published by the Economic and Social Council of the United Nations, Palais des Nations, Geneva, Switzerland; 8½ by 11, approximately 160 pages each, paper covered. Price: Volume I, $1.50; Volume II, $1.25.

This two-volume report by French, Swedish, Swiss, and English experts covers the work done by a Joint Technical Study Group on the problems of rural electrification in the less industrialized countries. The study was undertaken at the request of the Economic Commission for Europe and made possible by the help of the United Nations Technical Assistance Administration and the Food and Agriculture Organization. The two volumes comprise a series of papers prepared on general problems of electric generation, transmission, and utilization in rural areas.

★ ★ ★

Water Conditioning Data Book, No. 2478A, is pocket size, 108 pp., leatherette volume. Prepared by The Permutit Company, 330 W. 42nd St., New York 36, N. Y., this practical reference volume supersedes an earlier volume produced in 1952. It presents a compilation of 78 chapters and tables brought up to date and completely revised. The subjects covered to name a few, include: hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed makeup requirements; alkalinity relationships, specific gravities, chemical reactions, hydraulic conversion factors, etc. This data book is available at no charge to practicing engineers and to those who work with water-conditioning problems.

CATALOG LIBRARY

Standard catalogs listed monthly to help you maintain a reference library

FUEL OILS, LUBRICANTS

201 Diesels, Their Fuels and Lubricants — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to speed is covered. A chart shows relation of engine performance to fuel properties. Sinclair Refining Co.

202 Petroleum Pitch — This illustrated article on petroleum pitch as a boiler fuel stresses its low cost, other advantages. Explains combustion of pitch; discusses unloading method, burning, storage, fuel oil treatment, also precautions in handling hot pitch. Kor Corp.

203 Turbine Lubrication — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations. DeLaval Separator Co.

204 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.)

205 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The special requirements of porous bearings are also discussed. The Texas Co.

It's easy to get these free catalogs—just circle item numbers of those wanted on the post card at right.

206 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compres-

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY—

POWER ENGINEERING

110 South Dearborn

CHICAGO 3, ILLINOIS

FIRST CLASS
Sec. 349 P.L.&R.
PERMIT No. 353
CHICAGO, ILL.

JANUARY, 1955
Card void after July 31, 1955

POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the numbers circled below.

Name.....Title.....

Company Name.....
(Must be included)

Company Address.....

City.....State.....
(If you prefer delivery at home, give home address, too)

Home Address.....

City.....State.....

Equipment

1	2	3
4	5	6
7	8	9
10	11	12
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	30
31	32	33

Helpful Bulletins

101	102	103	104	105	106
107	108	109	110	111	112
113	114	115	116	117	118
119	120	121	122	123	124
125	126	127	128	129	130
131	132	133	134	135	136
137	138	139	140	141	142
143	144	145	146	147	148
149	150	151	152	153	154
155	156	157	158	159	160
161	162	163	164	165	166

Catalog Library

201	202	203	204	205	206	207	208	209	210	211	212
213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236
237	238	239	240	241	242	243	244	245	246	247	248
249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272
273	274	275	276	277	278	279	280	281	282	283	284
285	286	287	288	289	290	291	292	293	294	295	296
297	298	299	300	301	302	303	304	305	306	307	308

Advertised Products and Services

501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521
522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542
543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563
564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584
585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605

Use this space to ask for tear sheets and other information.

sor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, also safety precautions. Cities Service Petroleum, Inc.

207 Cooperative Technical Consultation Service — This informative 24-pp booklet presents company's periodic consultation service aimed at the most efficient use of petroleum products. Covers services available in the solution of lubrication problems, metal working operations, processing, fuel oils, dust control. Gulf Oil Corp., Gulf Refining Co.

BURNERS

208 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

209 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. Specifications included. The Engineer Co.

210 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

COAL, ASH HANDLING

211 Economic Coal Storage — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses flexibility, low operating costs. Also shows how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; pictures several models. Tractor Div., Allis-Chalmers Mfg. Co.

212 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

213 Automatic Coal Scale — Sixteen-pp Bulletin 0352 describes an automatic coal scale for weighing coal as it is fed to boilers, enabling a power engineer to maintain a constant check on boiler efficiency. Book gives construction and operating details on the belt feeder, weigh hopper, scale housing, operating levers and accessories. Photos and line drawings show scale features. Richardson Scale Co.

214 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven

JANUARY, 1958

Card void after July 31, 1958

POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the numbers circled below.

Name.....Title.....

Company Name.....
(Must be included)

Company Address.....

City.....State.....
(If you prefer delivery at home, give home address, too)

Home Address.....

City.....State.....

Equipment			Helpful Bulletins										Catalog Library										Advertised Products and Services										
1	2	3	101	102	103	104	105	106	201	202	203	204	205	206	207	208	209	210	211	212	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521
4	5	6	107	108	109	110	111	112	213	214	215	216	217	218	219	220	221	222	223	224	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542
7	8	9	113	114	115	116	117	118	225	226	227	228	229	230	231	232	233	234	235	236	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563
10	11	12	119	120	121	122	123	124	237	238	239	240	241	242	243	244	245	246	247	248	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584
13	14	15	125	126	127	128	129	130	249	250	251	252	253	254	255	256	257	258	259	260	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605
16	17	18	131	132	133	134	135	136	261	262	263	264	265	266	267	268	269	270	271	272																							
19	20	21	137	138	139	140	141	142	273	274	275	276	277	278	279	280	281	282	283	284																					
22	23	24	143	144	145	146	147	148	285	286	287	288	289	290	291	292	293	294	295	296																					
25	26	27	149	150	151	152	153	154	297	298	299	300	301	302	303	304	305	306	307	308																					
28	29	30	155	156	157	158	159	160																																	
31	32	33	161	162	163	164	165	166																																	

Use this space to ask for bear sheets and other information.

.....

.....

BUSINESS REPLY CARD
No Postage Necessary if Mailed in the United States

POSTAGE WILL BE PAID BY—

POWER ENGINEERING

110 South Dearborn

CHICAGO 3, ILLINOIS

FIRST CLASS
PERMIT No. 353
Sec. 34.9 P.L.&R.
CHICAGO, ILL.

reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

215 Pneumatic Handling System — Of value to power engineers concerned with the handling of dry pulverized materials, 16-pp Bulletin G-2 tells how handling costs can be reduced by using the proper pneumatic handling system. Lists 86 dry pulverized materials and indicates which of three systems is best suited to handle each material. Discusses company's system for conveying such materials as Portland cement, pulverized coal. Fuller Co.

217 Burning Bituminous Coal — This 24-pp illustrated booklet is a compilation of numerous actual case histories of industrial plants and institutions which burn bituminous coal "the modern way." Stressing operating economy achieved, these case histories show problems overcome, equipment used, and savings realized. Bituminous Coal Institute.

218 Fly Ash Collection — The successful and economical separation of fly ash from boiler flue gases is discussed in 28-pp Catalog G405. Explains need for collection equipment and gives physical characteristics of fly ash. Describes company's Multiclone equipment as to principle of operation, performance and advantages. Western Precipitation Corp.

BOILERS, GENERATORS

219 Shop-Assembled Boiler — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

220 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 30,000 lb per hour. Space requirements are shown in a table along with typical specifications. Also described is control system. Combustion Engineering, Inc.

221 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

223 Automatic Boilers — This bulletin describes 17 sizes of Powermaster packaged automatic boilers from 15 through 500 hp for steam process, steam and hot water heating service. Lists such advantages as three-pass design, forced draft and automatic controls. Describes firing equipment for light and heavy oils, gas; shows various fuel firing arrangements. Orr & Sembower, Inc.

TUBING AND ACCESSORIES

224 Condenser Tubes — Excellent information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Gives details on proper installation. Scovill Mfg. Co.

225 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

WATER CONDITIONING

226 Handbook on Demineralizing — Bulletin 5800, 39 pp, on treating water by demineralizing, explains principle of ion exchange. Discusses applications of many anion and cation exchange materials; series of curves help estimate cost of operation. Describes design and operation of demineralizer systems, multi-stage systems and mixed bed units. Includes curves of water quality obtainable. Cochrane Corp.

227 Modern pH and Chlorine Control — This 100-pp booklet gives details in color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; feedwater. W. A. Taylor & Co.

228 What's What on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, Super Nalcolite. National Aluminate Corp.

229 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

PUMPS, PUMPING

230 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up is the subject of 12-pp Bulletin 1525. De Laval Steam Turbine Co.

231 Gear Pumps — Besides presenting all of company's standard gear pumps, 24-pp Bulletin 17-A describes briefly some special types engineered for unusual requirements. Discusses design, construction and operation of the pumps; tells how they're used in the power and industrial fields. Drawings, action photos, capacity and pressure tables and performance data supplement the text. Booklet covers pumps ranging from 1 gph to 1000 gpm capacities. Schutte and Koerting Co.

PACKINGS, GASKETS, SEALS

232 Seals for Bearings — Complete information on manufacturer's Klozure oil and grease seals for bearings is available in 100-pp Catalog 10. Fully illustrated in color, pictures all types of these seals, typical applications and lists sizes and part numbers. Also describes mechanical pressure seals for rotary shafts. The Garlock Packing Co.

233 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for many applications. Packing Div., Raybestos-Manhattan, Inc.

VALVES, TRAPS, PIPING AND ACCESSORIES

234 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

235 Lubricated Plug Valves — Revised Catalog PV-2, 12 pp, presents steel and semi-steel valves designed to offer quick shut-off of erosive or corrosive fluids. Explains advantages of the lubricated tapered plug design of these valves and pictures single gland, screwed gland, and bolted gland types. Also shows accessories. The William Powell Co.

236 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

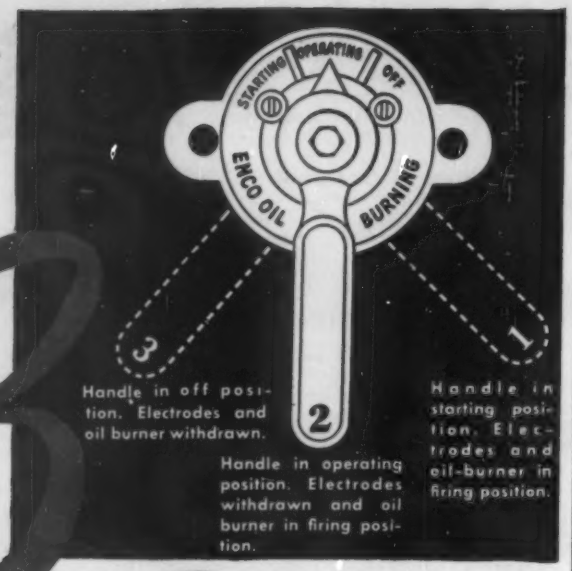
237 Blow-Off Valves — Bulletin B-426, 20 pp, on blow-off valves for boiler pressures up to 400 lb wsp, contains installation recommendations, construction information on Yarway seatless and double-tightening blow-off valves. Gives full ordering data. Yarnall-Waring Co.

238 For Precise Control — Fifty-pp Catalog 17 covers manufacturer's line of disc valves and accessories, providing full selection and ordering data, materials of construction, sizes. Describes manual and automatic controls for these valves which, it is noted, are available in any metal which can be cast or welded. Minimum pressure drop, quick closure, simplicity and other advantages are discussed. R. S. Valve Div., S. Morgan Smith Co.

239 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are also discussed and the importance of stem operation is treated. A chapter covers materials of construction. Crane Co.

240 Steel Gate Valves — Five types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin

Hand Control Valve for cylinders . . . wall mounting . . . oil burner ignition system.



3 Step IGNITION SYSTEM FOR PULVERIZED COAL, OIL, OR GAS

FAST
SAFE
POSITIVE

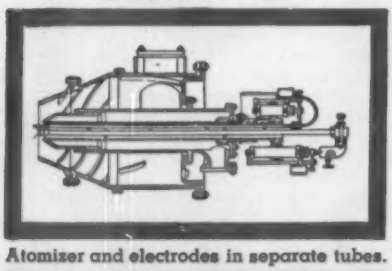
With an Enco Ignition System, operator can light off any burner by movement of a Hand Control Valve, located close to the pulverized-coal mill and fan controls, and within view of the instrument board. Automatically, a powerful ignition spark is established, and the light fuel turned on. Both are interlocked electrically — **the oil valve cannot be opened until the spark current is on and the atomizer is in firing position.** After the oil flame is established, a second movement of the control valve retracts the electrodes, leaving the atomizer in operation.

After ignition of the pulverized coal is established, a third movement of the control valve shuts off the oil and retracts the atomizer out of the hot zone, leaving the unit ready to repeat the operation as may be needed.

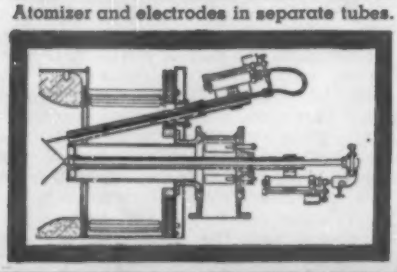
The Enco Ignition System has a wide range of application. Pulverized coal, blast furnace gas or any liquid fuel may be ignited by the unit, or the spark alone may be used to ignite natural or refinery gas. The ignition flame can be changed gradually from light to heavy fuel oil if continued operation under heavy load is required. The ignition flame also can be used as a substitute for principal fuel in emergencies.

Bulletin on request.

Atomizer and electrodes in the central tube.



Atomizer and electrodes in separate tubes.



THE ENGINEER COMPANY
75 West Street, New York 6, N. Y.

Enco OIL BURNING EQUIPMENT

For more data circle 545 on Post Card

202 B, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

241 Improved Pipe Hanger — Twelve-pp Bulletin 153 describes company's Counterpoise pipe hanger for high temperature piping systems in steam generating stations, refineries and chemical plants. Tells how it offers efficient load supporting effort of constant value throughout entire range of travel as pipe expands or contracts because of temperature changes. Graphs for selecting proper hangers are given. National Valve & Mfg. Co.

242 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

243 Industrial Steam Traps — Twelve-pp Bulletin 853 describes steam traps with bellows of bronze, Monel or stainless steel, and bodies in bronze, semi-steel and cast steel construction in sizes ¼ to 2 in., for pressures from vacuum to 300 lb. Included besides capacity tables and dimensions are piping diagrams, typical applications. W. H. Nicholson & Co.

244 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

REFRACTORIES

245 Refractories for Heat, Power — Compiled to help power engineers solve refractory problems and get greater operating efficiency from their boilers, this booklet provides 32 pp of practical information on company's Crystolon refractories. Properties and characteristics of these silicon carbide products are given and separate chapters cover those for air-cooled, solid wall and water tube protection, and for repairs. Norton Co.

246 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Charts and tables afford easy reference for technical data. Universal Atlas Cement Co.

ELECTRICAL EQUIPMENT

247 Motor-Generator Reference Book — Publication 51R7933 is a 50-pp booklet compiled to assist in the selection of motive power to handle most industrial applications. Neither text book nor ordering catalog, this book provides a brief outline of the various types of motors, generators and motor-generator sets, telling their applications and operating requirements. Booklet is generously illustrated and includes performance data, ratings, information on methods of speed control. Allis-Chalmers Mfg. Co.

248 Motor Lubrication — Three methods of lubricating electric motors — cartridge, standard open and company's Lubriflush — are compared in 8-pp Bulletin 1848. To demonstrate action of relubrication in Lubriflush bearings, a series of natural color photos of a transparent bearing housing is reproduced. Necessity of annual lubrication is demonstrated photographically. U. S. Electrical Motors Inc.

249 Wire, Cable Ordering Guide — Newly-released General Catalog W-52-3, 186 pp, presents more than 500 different types of wires and cables. Contains comprehensive data on construction and operating characteristics for control and signal cables, cables for construction work, telephone wire and cables, and portable cords. A technical engineering data section is included. Available to qualified power engineers. United States Rubber Co.

250 Insulation Temperature-Resistance — Technical Publication 21T4, 16 pp, is an article on temperature-resistance characteristics of electrical insulation. Complete with tables and graphs, gives general information on variations in temperature characteristics, composite nature of electrical insulation, and practicability of temperature compensation. Other chapters deal with determining insulation constants for temperature correction factors, and a practical method of obtaining insulation temperature. James G. Biddle Co.

INSTRUMENTS AND CONTROLS

251 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

252 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feed water automatically. Copes-Vulcan Div., Continental Foundry & Machine Co.

253 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

OTHER EQUIPMENT

254 Refrigerator Condensers — Bulletin RC-2, 38 pp, utilizes drawings, tables and engineering data to show how to select proper type from company's line of ammonia and Freon condensers for refrigeration services. Illustrates horizontal multipass shell and tube types; vertical singlepass shell and tube types. Gives pipe sizes for ammonia and Freon lines; stands for condensers. Henry Vogt Machine Co.

255 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is

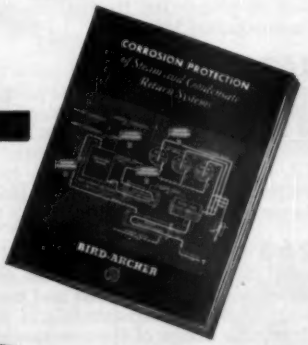
STOP CORROSION
with BIRD-ARCHER AMINE TREATMENT

Unretouched photograph shows the ravages of corrosion on condensate return lines.

Corrosion of piping in steam and condensate return lines is an expensive two-way headache. (1) It leads to large outlays for pipe replacement and maintenance. (2) It often results in plugged return lines and traps due to the solid products of corrosion. Bird-Archer Amine Treatment effectively eliminates these troubles at low cost.

Here's how. Amines are fed into the boiler or into the steam and condensate systems. The amines raise the pH value of the condensate and also tend to inhibit equipment-destroying corrosion through surface protection of the metal itself. In scores of plants, this Bird-Archer system has more than paid for itself by substantially cutting replacement and maintenance costs.

BA-902



Bulletin CP 100 gives all the facts on Bird-Archer Amine Treatment. Write for your copy.

LABORATORIES · ENGINEERS · CHEMISTS

BIRD-ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 4337 NORTH AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO

IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario
IN MEXICO: Calderas y Accesorios, S. A., Amsterdam 291, Mexico, D. F.

For more data circle 544 on Post Card

titled, "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

256 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

257 Belt Conveyor Carriers — Carriers designed for rugged jobs, exposure to dust and long service are the subject of illustrated Bulletin 453. Shows how their spun end rolls and welded steel frame contribute to extra strength and better balance. Stephens-Adamson Mfg. Co.

258 Industrial Equipment — Bulletin WP-1099-B61, 16 pp, describes manufacturer's industrial equipment including centrifugal refrigeration, condensers and coolers, steam power plant equipment, water conditioning deaerators and rotary pumps. Worthington Corp.

259 Power Plant Equipment — This comprehensive folder illustrates some of the equipment and services provided by this company. Shows heat exchangers, filters, condensers; also such services as re-tubing and metal spraying. Condenser Service & Engineering Co., Inc.

260 Water Heaters — Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-, four- and six-pass designs, removable tube bundles. Davis Engineering Corp.

261 Insulating Material — Ultrafine, a thermal and acoustical insulation made of blown glass fibers, is presented in this bulletin. Shows it in use; gives data on properties, thermal conductivity. Gustin-Bacon Mfg. Co.

262 Fluid Drive — Of value to power engineers interested in obtaining adjustable speed operation in a range from 100 to 2500 hp is 24-pp Bulletin 9319, illustrated in color. Covers company's Type VS, Class 4 Gyrol fluid drive, explaining its principle of operation and illustrating its use. American Blower Corp.

263 For Climate Control — Bulletin 122, 8 pp, introduces an air conditioner designed for precise and economical control of air temperature and moisture. Illustrates design of the new machine, tells its features, and pictures some installations. Niagara Blower Co.

264 Steam Accumulator — How the steam supply and demand can be balanced by means of company's steam accumulator is told in Bulletin RA-52-8. Stresses reduced boiler capacity required and increased boiler efficiency afforded by use of the accumulator, other advantages. Discusses operating principle, tells how to figure capacity. Foster Wheeler Corp.

This is the most complete line of No. 6 Fuel Oil Heaters ever offered to the industry!

TUBULAR TYPE (Steam)
U-TUBE TYPE (Steam or Hot Water)
STRAIGHT TUBE TYPE (Steam)
TANK SUCTION BELL HEATER (Steam or Hot Water)
TANK SUCTION TYPE (Steam or Hot Water)
"PARAPROBE"* Fuel Oil Heater (For Below-The-Water-Line Service)

Guards against oil leaks and automatically shuts down oil burner and pump in event of oil heater failure. A positive protection against oil in the boiler.

← TYPE "GF"*
Indirect Gas Fired Fuel Oil Heater
Generates its own supply of steam for heating the oil! Applicable to any type of oil fired apparatus. A radically new development!

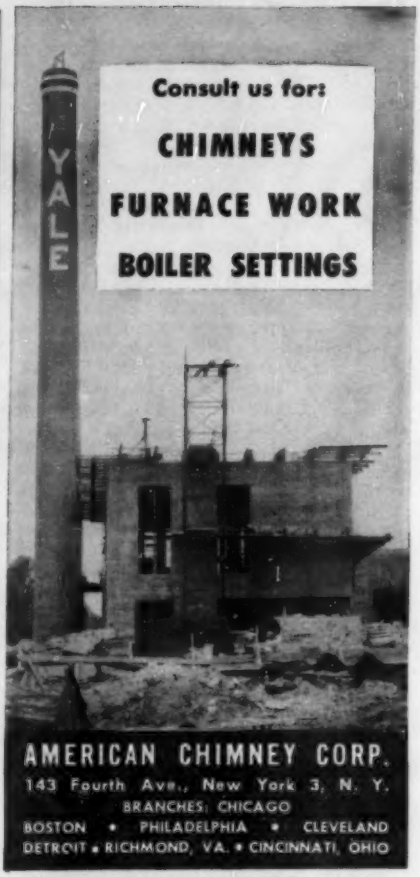
ALL PARACOIL Fuel Oil Heaters carry the stamp of approval of the BOARD OF STANDARDS & APPEALS CITY OF NEW YORK

see our catalog in Sweet's INDUSTRIAL INSTRUCTION FILE or write for copy

*Patents Pending

DAVIS ENGINEERING CORPORATION
1064 EAST GRAND STREET, ELIZABETH 4, NEW JERSEY
30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK

For more data circle 552 on Post Card



For more data circle 553 on Post Card

CLASSIFIED ADVERTISING

Mechanical Engineers with 3 to 10 years' experience in central station power plant design. Permanent position with fine opportunity for advancement. Write stating education, experience and salary desired. Location — Southeast. Write Box 1694, POWER ENGINEERING, 110 South Dearborn Street, Chicago 3, Illinois.

Mechanical Draftsman experienced in power plant piping. Write stating experience and salary desired. Location — Southeast. Write Box 1695, POWER ENGINEERING, 110 South Dearborn Street, Chicago 3, Illinois.

USE CLASSIFIED ADVERTISING
It Pays

J. E. SIRRINE COMPANY
Engineers
Design and Supervision of Steam and Hydro-electric Power Plants, Industrial Plants, Mechanical and Operating Surveys, Appraisals • Plans • Reports
Greenville, South Carolina

GAGE GLASSES AND
High Pressure Rubber Gaskets
ALL SIZES TO FIT YOUR GAGES
MAGNIFYING
ERNST WATER COLUMN & GAGE CO.
Send for Catalog — LIVINGSTON, N. J.

It's ELLISON for accuracy!

STRAIGHT LINE DRAFT GAGES

Unit mechanism—readily accessible or removed. Non-parallax pointers. All diafram types have free-floating, long-life diafram. Bell type gages, Bulletin 122—Diafram type, Bulletin 124.

DIAL DRAFT GAGES

Unit mechanism readily accessible or removed. One, two or three pointers. Powerful movement on knife edge bearings. Ask for Bulletin 122.

INCLINED DRAFT GAGES

Constant zero under wide range in room temperature. Level and tube are replaceable in the field. Stationary and portable types. Also accessories and pitot tubes. Ask for Bulletin 109.

U-PATH STEAM CALORIMETER

Combines throttling, separating and re-evaporating calorimeter in a single unit. Accuracy within 2° F. Simple to use. Ask for Bulletin 118.

ELLISON DRAFT GAGE CO.

550 W. MONROE ST. Since 1896 CHICAGO 6, ILL.

THE ELLISON LINE ALSO INCLUDES:

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Vertical Tube Gages—Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube-Saturator Gages—U Gages—Stationary and Portable—Air Filter Gages—Dial and Inclined Tube Types—Pitot Tubes—U Path Steam Calorimeters—Portable Gas Analyzers-Orsat Type

For more data circle 555 on Post Card

Ideal Sensitive Needle Valves

... WITH STAINLESS STEEL NEEDLES

If you require precise "sensitive" control of small flows in the handling of liquids and gases, you'll find that IDEAL needle valves can do no wrong. Available in more than 50 types and sizes, IDEAL valves can be applied to almost any service. They also have a working range to 1,000 PSI. "Vernier" indicating types can also be supplied.

Prompt delivery on all orders.
Write for full information to: Dept. B

IDEAL LABORATORY Tool and Supply Co.

Cheyenne, Wyo.

For more data circle 556 on Post Card

Can't Distort, Can't Misalign, because it has CANTILEVER DESIGN!

U.S. NEW TYPE GW SYNCROGEAR MOTOR

RIGHT-ANGLE WORM-GEAR

SOLID CAST UNIBASE

PYRAMIDAL SUPPORT

CLOSE-HITCH

SEALED PROTECTION

Mounting stresses absorbed. Gear and motor distortion-free.

Permanently accurate gear and bearing alignment are vital in right-angle, worm-gear. In the amazing new Type GW Syncrogear motor the *cantilever* principle is employed. Why? To prevent stress of motor and gear mounting. The single, solid-cast Unibase pyramidally supports the entire load, thereby avoiding mounting stresses and preventing distortion. All castings are normalized. This new design insures phenomenal motor life. Type GW is extremely compact. It permits close-hitch connection to any machine. Gear is sealed in dustproof case. Oil-dip lubrication. Asbestos-protected windings. Speeds, 20 to 155 r.p.m. Gear ratios up to 87:1. Horsepower, ¼ to 2.

U. S. ELECTRICAL MOTORS Inc.
Los Angeles 54, Calif. • Milford, Conn.

MAIL COUPON FOR TYPE GW SYNCROGEAR BOOKLET

U. S. Electrical Motors Inc.
P. O. Box 2058, Los Angeles 54, Calif. PE-1
or Milford, Conn.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE____

For more data circle 548 on Post Card

TAYLOR COMPARATORS

"never knew BOILER WATER pH and PHOSPHATE TESTS could be so easy!"

Just fill 3 test tubes with the sample to be tested and place them in the base...

add reagent to middle tube only...

place color standard slide on base. Move the slide across until the colors match and...

There's the Value!

You can make pH, chlorine, phosphate or nitrate determinations with these 3 easy steps with Taylor Comparators. Complete water analysis, including fluorides, is only a little more detailed when you use a Taylor Water Analyzer. Taylor sets are lightweight, durable, portable. Many different tests can be made on a single base. Best of all . . .

COLOR STANDARDS ARE GUARANTEED

Taylor liquid color standards carry an unlimited guarantee against fading, thus there's no chance of mechanical inaccuracy. Since a complete set of standards for any one determination is enclosed in a sturdy plastic slide, there's no need to handle fragile single standards.

SEE YOUR DEALER for Taylor sets or write direct for FREE HANDBOOK, "Modern pH & Chlorine Control." Gives theory and application of pH control, illustrates and describes full Taylor line.

SERVING SCIENCE AND INDUSTRY 1930 1955 FOR 25 YEARS

W. A. TAYLOR AND CO.
410 RODGERS FORGE RD. • BALTIMORE 4, MD.

ADVERTISERS' INDEX

AIR PREHEATER CORP., INC. 15
Agency—G. M. Basford Company

ALLIS-CHALMERS MFG. CO. 31
Agency—Compton Advertising, Inc.

ALLIS-CHALMERS MFG. CO. (TRACTOR DIV.) ..... *
Agency—Bert S. Gittins Advertising

AMERICAN BLOWER CORP. 42–43
Agency—Brooke, Smith, French & Dorrance, Inc.

AMERICAN CHAIN & CABLE CO., INC. ..... *
Agency—Reincke, Meyer & Finn, Inc.

AMERICAN CHIMNEY CORP. 108

AMERICAN ENGINEERING CO. ..... *
Agency—Beatty and Oliver, Inc.

ARMSTRONG MACHINE WORKS 2
Agency—Russell T. Gray, Inc.

BABBITT STEAM SPECIALTY CO. 111
Agency—George T. Metcalf Co.

BABCOCK & WILCOX CO., THE 12–13
Agency—O. S. Tyson and Co., Inc.

BAILEY METER COMPANY 53
Agency—Fuller & Smith & Ross, Inc.

BALTIMORE & OHIO RR. ..... *
Agency—Richard A. Foley, Inc.

BELMONT PACKING & RUBBER CO., THE ..... *
Agency—Rea, Fuller & Co.

BIDDLE, JAMES G., CO. 30
Agency—The Roland G. E. Ullman Org.

BIRD-ARCHER CO., THE 107
Agency—The Roland G. E. Ullman Org.

BITUMINOUS COAL INSTITUTE 7
Agency—Vansant, Dugdale & Co., Inc.

C & D BATTERIES ..... *
Agency—John T. Hall & Co.

CAMBRIDGE INSTRUMENT CO., INC. ..... *
Agency—E. M. Freystadt Associates, Inc.

CHAPMAN VALVE MFG. CO., THE ..... Inside Back Cover
Agency—Sutherland-Abbott

CLARK MFG. CO. ..... *
Agency—Belden & Hickox

COCHRANE CORPORATION 91
Agency—Hening & Co., Inc.

COMBUSTION ENGINEERING, INC. 18–19
Agency—G. M. Basford Company

CONDENSER SERVICE AND ENGINEERING 111
Agency—Joseph S. Vogel & Co.

CONOFLOW CORP. ..... *
Agency—The Roland G. E. Ullman Org.

COPES-VULCAN DIVISION, CONTINENTAL FOUNDRY & MACHINE COMPANY 10–11
Agency—Davies and McKinney

CRANE CO. 45
Agency—The Buchen Company

DART UNION CO. 102
Agency—Sutherland-Abbott

DAVIS ENGINEERING CORPORATION 108
Agency—Thomas & Delehanty, Inc.

DEARBORN CHEMICAL CO. ..... *
Agency—The Buchen Co.

DE LAVAL SEPARATOR CO., THE 21
Agency—Donahue & Coe, Inc.

DE LAVAL STEAM TURBINE CO. 16
Agency—Michel-Cather, Inc.

EDWARD VALVES, INC. ..... *
Agency—Marsteller, Gebhardt & Reed, Inc.

ELLIOTT CO. ..... Inside Front Cover
Agency—Peterson & Kempner, Inc.

ELLISON DRAFT GAGE CO. 109
Agency—Tri-State Advertising Co., Inc.

ENGINEER CO., THE 106
Agency—Michel-Cather, Inc.

ERNST WATER COLUMN & GAGE CO. ..... *
Agency—Lasky Co.

EVERLASTING VALVE CO. ..... *
Agency—Michel-Cather, Inc.

FOSTER WHEELER CORP. 22–23
Agency—Rickard & Co., Inc.

GARLOCK PACKING CO., THE 96
Agency—Hutchins Advertising Company, Inc.

GENERAL CABLE CORP. 14
Agency—Hicks & Greist, Inc.

GENERAL ELECTRIC CO. 33–38
Agency—G. M. Basford Co.

GRINNELL CO., INC. ..... *
Agency—Horton-Noyes Company

GULF OIL CORP. ..... *
Agency—Young & Rubicam, Inc.

GUSTIN-BACON MFG. CO. 17
Agency—Valentine-Radford Advertising

HAGAN CORPORATION ..... *
Agency—Ketchum, MacLeod & Grove, Inc.

HAYS CORPORATION, THE ..... *
Agency—Proebsting, Taylor, Inc.

IDEAL LABORATORY TOOL & SUPPLY CO. 109
Agency — Baccard, Dunshee & Jacobson, Inc.

KIRK & BLUM MFG. CO. ..... *
Agency—The S. C. Baer Co.

LESLIE CO. ..... *
Agency—Macready, Handy & Van Denburgh

MANNING, MAXWELL & MOORE, INC. 101
Agency—Fuller & Smith & Ross, Inc.

NATIONAL ALUMINATE CORPORATION 24
Agency—Armstrong Advertising Agency

NATIONAL VALVE & MFG. CO. 39
Agency—Bond & Starr, Inc.

NIAGARA BLOWER COMPANY 32
Agency—The Moss-Chase Company

NORTON COMPANY ..... *
Agency—James Thomas Chirug Company

OHIO INJECTOR CO. ..... *
Agency—Fuller & Smith & Ross, Inc.

ORR & SEMBOWER, INC. 47
Agency—Beaumont, Heller & Sperling, Inc.

PEABODY ENGINEERING ..... *
Agency—Richard La Fond Advertising, Inc.

PERMUTIT CO., THE ..... Back Cover
Agency—Cunningham & Walsh, Inc.

POWELL VALVES 28
Agency—The Ralph H. Jones Co.

PREFERRED UTILITIES MFG. CORP. ..... *
Agency—Spooner & Kriegel

QUAKER RUBBER CORP. 95
Agency—Fox & MacKenzie Advertising

RAYBESTOS-MANHATTAN, INC. 100
Agency—Gray & Rogers

REPUBLIC FLOW METERS CO. ..... *
Agency—Glenn, Jordon, Stoetzel, Inc.

RILEY STOKER CORPORATION 40–41
Agency—The Davis Press, Inc.

ROTO DIV. OF ELLIOTT CO. 29
Agency—Jos. S. Vogel & Co.

SCHUTTE & KOERTING 99
Agency—Harris D. McKinney, Inc.

SCOVIL MFG. CO. 20
Agency—Robotham & Peck, Inc.

SIMPLEX VALVE AND METER CO. ..... *
Agency—Cunningham & Walsh, Inc.

SINCLAIR REFINING CO. 5
Agency—Morey, Humm & Johnstone, Inc.

SMITH CO., S. MORGAN 93
Agency—Fuller & Smith & Ross, Inc.

STANDARD OIL CO. (INDIANA) ..... *
Agency—D'Arcy Advertising Co.

STEPHENS-ADAMSON MFG. CO. 27
Agency—Glenn-Jordon-Stoetzel, Inc.

STONE & WEBSTER ENGINEERING CORPORATION ..... *
Agency—Harold Cabot & Co., Inc.

TAYLOR & CO., W. A. 110
Agency—Emery Advertising Corporation

U. S. ELECTRICAL MOTORS, INC. 109
Agency—The McCarty Co.

UNITED STATES RUBBER COMPANY 49
Agency—Fletcher D. Richards, Inc.

UNIVERSAL ATLAS CEMENT CO. 112
Agency—Batten, Barton, Durstine & Osborn, Inc.

VAN DER HORST CORP. 94

VOGT MACHINE CO., HENRY 97
Agency—Farson, Huff & Northlich

WALLACE & TIERNAN PRODUCTS, INC. ..... *
Agency—Branstate Associates, Inc.

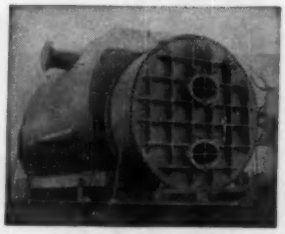
WING MFG. CO., L. J. 98
Agency—Willard G. Myers Advertising Agency

WORTHINGTON CORPORATION 51
Agency—James Thomas Chirug Company

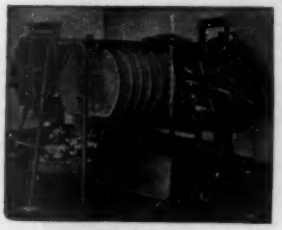
YARNALL-WARING COMPANY 8–9, 54
Agency—The Michener Co.

PERFORMANCE
IS BUILT INTO ALL
HEAT TRANSFER EQUIPMENT
by

CONSECO



CONDENSERS



REFINER FILTERS

Performance is the true yard stick for measuring cost. Ejectors — Condensers — Deaerators — Steam Air Jet Closed Heaters—Heater Units made by Condenser Service & Engineering Company perform not only as stated in contract, but for more than the contract calls. It is the extra trouble free service you want to consider when figuring the cost.

Send for full information, with illustrated literature. Tell Conseco Engineers your troubles and see how quickly they find the correct solutions. They are waiting to help you.

EVAPORATORS

STEAM JET AIR EJECTORS

CLOSED HEATERS

Condenser Service & Engineering Co., Inc.

158 Observer Highway, Hoboken, N. J.

HOboken 3-4425

N. Y. Tel.: BA 7-0600

For more data circle 547 on Post Card

Sign Your

DECLARATION OF INDEPENDENCE

☆

Buy U. S. Savings Bonds!

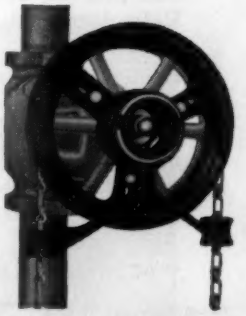
Protect Your Manpower with...

Babbitt *Adjustable* SPROCKET RIM *with Chain Guide*

Control out-of-reach overhead valves right from the floor! No more climbing on ladders, balancing on boilers, perching on workbenches or machines. Prevent accidents and costly claims — also save fuel, steam and money.

Only four simple, quickly-assembled parts installed and operating in only a few minutes, Babbitt Adjustable Sprocket Rim with Chain Guide —

- **Fits all valve wheels**
- **Simplifies pipe layouts**
- **Eliminates risky climbing**



Range of 10 adjustable sizes fits all valve wheels from 2 to 30 inches diameter, with rising or non-rising stems.

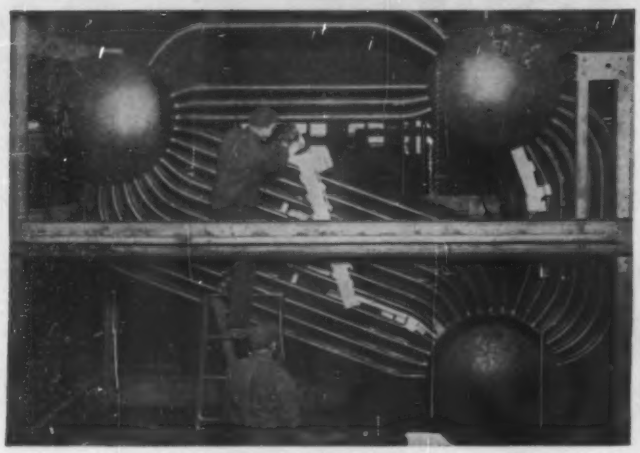
Call your Industrial Distributor. He carries complete stocks.

Babbitt STEAM SPECIALTY CO.

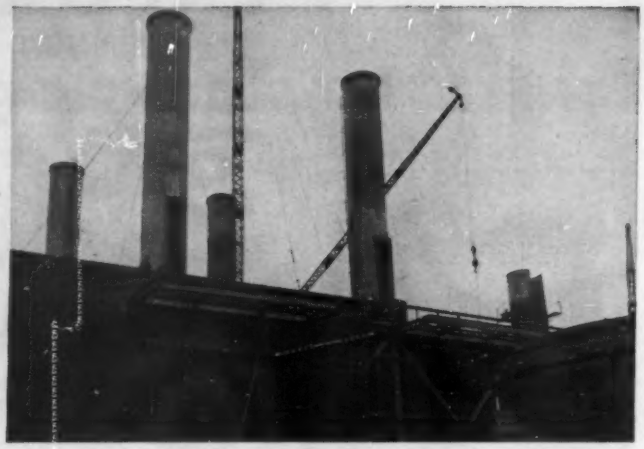
4 BABBITT SQUARE, NEW BEDFORD MASSACHUSETTS

For more data circle 551 on Post Card

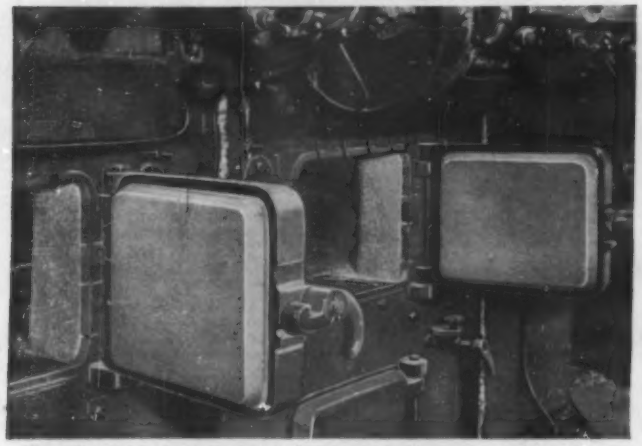
IN POWER PLANTS ON JOBS LIKE THESE:



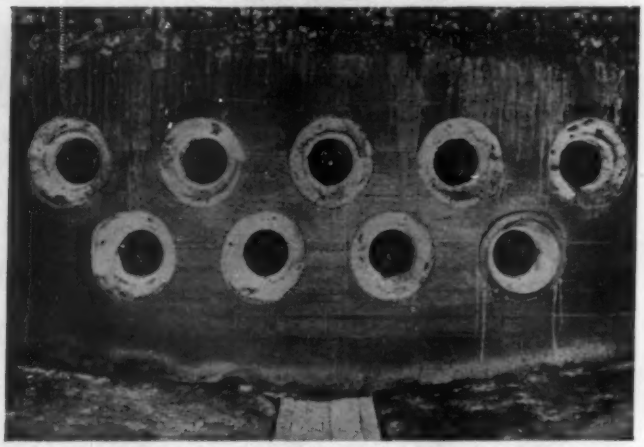
Monolithic gas-tight baffles of Refractory Concrete are easily made with a castable refractory and simple forms.



Lumnite steel stack linings keep drafts up and costly repairs due to corrosion and abrasion down.



Door linings and other special shapes are easily cast in molds with adaptable Castable Refractory Concrete.



Front wall of boiler is lined with 9 inches of Refractory Concrete—section in excellent condition after a year of service.

Castables save time and cut costs

Power-plant engineers find that castable refractories provide a fast, easy way to place or repair linings in steel stacks, breechings, boiler walls and hearths, doors, coal bunkers and ash pits. Refractory and insulating concrete made with castables can be mixed simply by adding water right on the job, and casting into place. Costs are cut and time saved because they reach service strength within 24 hours—and usually give better service than other refractories.

Castables are prepared mixes of Lumnite* calcium-aluminate cement and special aggregates selected to meet specific temperature and insulation service. They are made by manufacturers of refractories, sold through their dealers, and come ready-made for many refractory jobs.

There is no need to stock large inventories of special refractory shapes—they can be cast as needed. Keep a supply of your favorite brand of Lumnite castable on hand ready for a rush job. For more information write: Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, New York.

**"LUMNITE" is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PE-L-84R

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

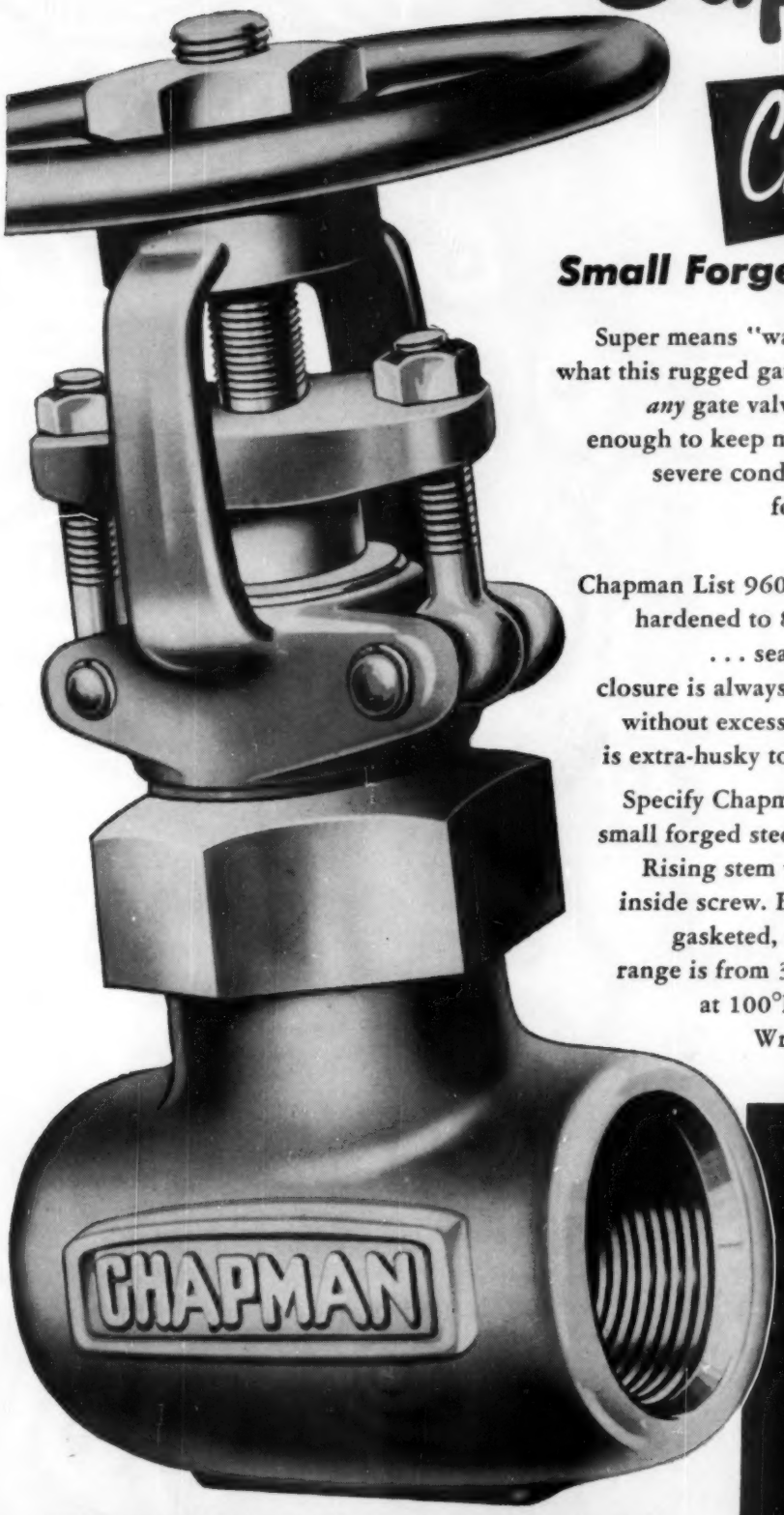
UNITED STATES STEEL HOUR—Televised alternate weeks—See your newspaper for time and station.

For more data circle 559 on Post Card

Super Tough

Chapman List 960

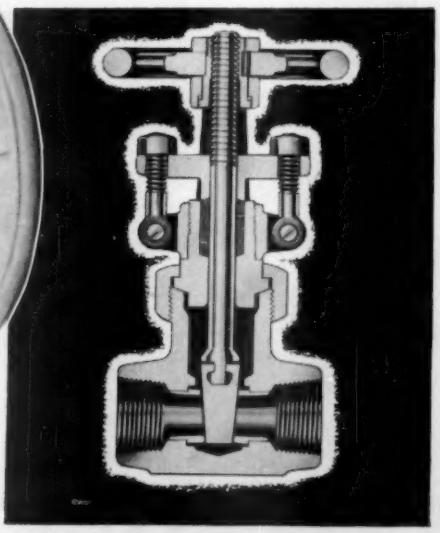
Small Forged Steel Gate Valve



Super means "way beyond the ordinary" and that's just what this rugged gate valve is . . . it's tough enough to lick *any* gate valve problem in its range . . . dependable enough to keep maintenance costs down under the most severe conditions. That's why List 960 is specified for more different applications than any other valve of its kind.

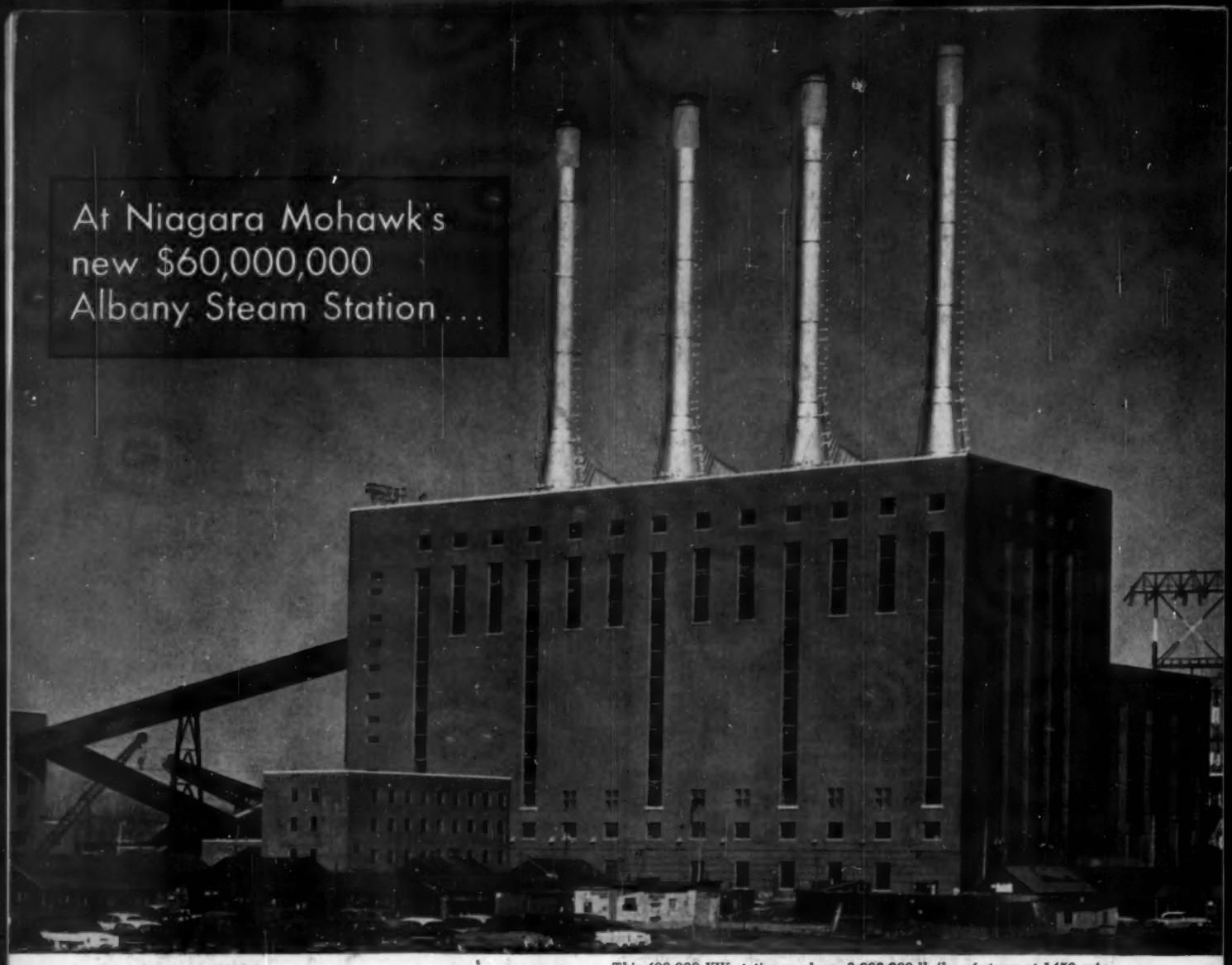
Chapman List 960 is tough because . . . wedge faces are hardened to 800 Brinell, so they won't seize or gall . . . seat rings are hardened stainless steel, so closure is always tight and operation is always smooth, without excessive wear . . . stem-and-gate connection is extra-husky to stand up under even unusual stresses.

Specify Chapman List 960 for every use you have for small forged steel gate valves. In sizes from ¼" to 2". Rising stem with yoke (shown) or rising stem with inside screw. Bonnet joint is either metal to metal or gasketed, depending upon application. Pressure range is from 380 pounds at 1000°F to 2000 pounds at 100°F. For higher ratings, specify List 990. Write today for your copy of Catalog 10.



The CHAPMAN Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

For more data circle 560 on Post Card



This 400,000 KW station produces 2,600,000 lb./hr. of steam at 1450 psig.

Permutit Demineralizers deliver highest quality make-up... and save money, too!

Albany Station's Mixed-Bed Demineralizer was guaranteed to produce make-up of not over 0.5 ppm total solids (about 1 micromho in conductivity), silica of not over 0.1 ppm. It is consistently delivering *better* make-up—0.1 to 0.3 micromhos in conductivity, silica of 0.03 ppm.

Operators are enthusiastic! They like the availability of this Permutit Demineralizer. It is independent of the heat cycle—supplies plenty of make-up for filling a boiler after a shutdown, delivers water at low loads when evaporators would not be available.

Automatic Regeneration saves money! High-capacity Permutit ion exchange resins require fewer regenerations. Motor-driven valves automatically backwash and separate the two resins, individually regenerate and rinse the beds, evenly blend the resins and return the unit to service. Operators have only to keep charges of regenerating chemicals ready.

For performance and cost data on this installation or aid in solving your water problem, write The Permutit Company, Dept. PE-1, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

WATER CONDITIONING HEADQUARTERS

PERMUTIT®

For more data circle 561 on Post Card